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ABSTRACT

This sourcebook consists of background information and activities related to groundwater protection. The first section focuses on the characteristics of groundwater, the water cycle, stormwater runoff, and uses of groundwater. The second section addresses household hazardous materials--both from a safety standpoint and a groundwater standpoint. The third section provides information on groundwater threats in the community as a whole, including sources of groundwater contamination in Michigan, storage and handling of materials at business sites, hazardous waste management and state laws, and water well testing. The background information and hands-on projects are directed toward junior high and middle school science and social studies teachers. Materials may be used as a supplement to science/social studies curricula, as special units on groundwater quality or household hazardous materials, or as materials for a 1-hour or 1-day discussion of groundwater quality protection. Activities include demonstrations of soil infiltration and groundwater contamination, using readily available materials. Although directed toward upper elementary and junior high school classrooms, much of the material can be tailored to either older or younger students and can be used by scout and youth leaders. (JN)

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GROUNDWATER QUALITY PROTECTION IN OAKLAND COUNTY: A SOURCEBOOK FOR TEACHERS

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GROUNDWATER QUALITY PROTECTION IN OAKLAND COUNTY: A SOURCEBOOK FOR TEACHERS

East Michigan Environmental Action Council

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One Northfield Plaza, Troy, MI., 48098, April, 1984.

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TABLE OF CONTENTS

CREDITS

TABLE OF CONTENTS

NOTE TO TEACHERS

Why Groundwater Quality Protection?
Purpose of the Sourcebook
Origin of the Sourcebook

PART I: INTRODUCTION TO GROUNDWATER QUALITY

What is Groundwater	2
The Water Cycle	3
How Does Groundwater Contamination Occur?	6
Understanding Stormwater Runoff	8
Water Use in Oakland County	9

Introduction to Groundwater Quality - Classroom Activities

#1: What Is Groundwater	15
#2: Water Infiltration in Soils	17
#3: Simple Version of a Well (Introduction to Activity #4) ...	19
#4: Movement of Groundwater and Contaminants	20
Worksheet: Locating Groundwater Contamination	24

PART II: AWARENESS AND MANAGEMENT OF HOUSEHOLD HAZARDOUS MATERIALS

Poisons in the Home: Household Hazardous Materials	26
What Does Hazardous Mean?	27
Hazards from Selected Household Materials	28
Routes to Groundwater	33
Proper Disposal of Household Hazardous Materials	34

Awareness and Management of Household Hazardous Materials - Classroom and Home Activities

Letter to Parents	39
Location of Household Hazardous Materials (handout)	40
Classroom Worksheet: Household Cleaners - Reading Labels	41
Home Worksheet: Household Hazardous Products - Reading Labels	42
Household Hazardous Materials - Routes to Groundwater (hdout)	43
Cookies Aren't the Only Things Little Kids Put in Their Mouths When Grown-Ups Aren't Looking (handout)	44
How a Septic System Works (handout)	46
Household Materials Most Likely to Be Groundwater Hazards: Tips for Disposal (handout)	47
Home Practices to Protect Groundwater	48

(continued, next page)

PART III: THREATS TO GROUNDWATER IN THE COMMUNITY

The Challenge: Maintaining Groundwater Quality in the Community	50
Sources of Groundwater Contamination in Michigan	52
Storage and Handling of Materials and Waste at Business Sites ...	57
Management of Hazardous Waste from Business Sites	60
Water Well Testing Options	63
Who Is Responsible for Groundwater Quality Protection?	64
 <u>Threats to Groundwater in the Community - Classroom Activities</u>	
List of Activities	67
GLOSSARY	68
FOR FURTHER INFORMATION	70

NOTE TO TEACHERS

Why Groundwater Quality Protection?

Toxic waste dumps, hazardous chemicals, and groundwater contamination are headline stories throughout Michigan. Governor Blanchard has placed funding for toxic waste site cleanups at the top of his environmental agenda, with nearly \$25 million requested. Citizens living near sites of groundwater contamination are expressing concern and pushing for a response from responsible parties.

But the toxic waste disposal headlines fail to communicate the real importance of groundwater quality protection. The concern in Michigan is not just with major contamination sites and waste from large-scale industries. The concern is more basic: protection of Michigan's groundwater resources from a wide range of dispersed sources.

Groundwater is the primary source of drinking water for over one-half of all Michigan residents. Michigan citizens take pride in the state's natural resources and outdoor recreation areas, many of which are linked to water. Groundwater is an intrinsic part of the state's water resources--connected to rainwater and surface water through the water cycle.

No one can precisely describe the present quality of Michigan's groundwater, since extensive tests of private water wells throughout the state have not been made; but it is believed and hoped that there is time to avert many crises and problems. Groundwater is a resource which can be easily contaminated, but with a thoughtful and alert citizenry, groundwater quality can also be protected.

Purpose of the Sourcebook

The materials in this Sourcebook are intended as a reference source on groundwater quality protection. The characteristics of groundwater, the water cycle, and uses of groundwater are described in the first section. The second section addresses household hazardous materials -- both from a safety standpoint and a groundwater hazard standpoint. The third section provides information on groundwater threats in the community as a whole.

The Sourcebook materials may be used in a variety of ways:

- .As a supplement to science or social studies curricula;
- .As special units on groundwater quality or household hazardous materials; and/or
- .As materials for a one-hour or one-day discussion of groundwater quality protection.

Although directed toward the upper elementary and junior high classroom, much of the material can be tailored to either older or younger students. It is hoped that scout leaders, community leaders, and others will become familiar with the easy-to-do projects in the Sourcebook and carry them to student groups.

The nature and character of groundwater in Michigan is very different from groundwater in other parts of the United States. In the Southwest, for example, concerns focus on depletion of groundwater supplies. In Michigan, groundwater often comes from glacial sand deposits. This Sourcebook reflects the specific characteristics and contamination hazards which are of concern in Michigan.

Origin of the Sourcebook

The need for this Sourcebook was first identified by the West Oakland Groundwater Leadership Team--a group of citizens from West Oakland communities who are committed to groundwater quality protection and public education. Project ideas and the scope of the Sourcebook evolved through a series of workshops and meetings of the Leadership Team held during the fall of 1983. Special advisors and area teachers have assisted in the review and fine-tuning of the materials.

The response from teachers and the educational community has been positive and always supportive. The project team is especially grateful for the time, ideas, and enthusiasm of Dr. Donald Maxwell, Oakland Schools, and the teachers who volunteered time to pilot test the classroom projects.

Because the Sourcebook on Groundwater Quality Protection is new, we would appreciate your help in evaluating its utility. Suggestions for improvements and ideas for additional projects are welcome. Please contact us at any time. We would like to hear from you.

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INTRODUCTION TO GROUNDWATER QUALITY

Introduction to Groundwater Quality

What Is Groundwater?

Vast supplies of fresh water, called groundwater, are hidden beneath the earth's surface. In the United States, the quantity of water stored underground is 20 to 30 times greater than the water of all lakes, streams, and rivers combined. Between 40 and 50 percent of the population of the United States depends upon groundwater as its primary source of drinking water. Similarly, approximately 50 percent of Michigan's population depends on groundwater. In rural and semi-rural areas of Oakland County (beyond the urbanized suburbs of Southeast Oakland County) an estimated 97 percent of the population depend on groundwater for drinking and many other uses.

Groundwater is water that occurs in permeable, saturated layers (strata) of rock, sand or gravel. The upper surface of the groundwater zone is called the water table. Water beneath the water table is called groundwater. Water above the water table is soil moisture. Aquifers are subsurface formations which hold relatively large quantities of groundwater and which are able to readily transmit the water to wells.

In Oakland County, Michigan, groundwater is not an underground, free-flowing river. The water in the aquifer lies in beds of sand and gravel,

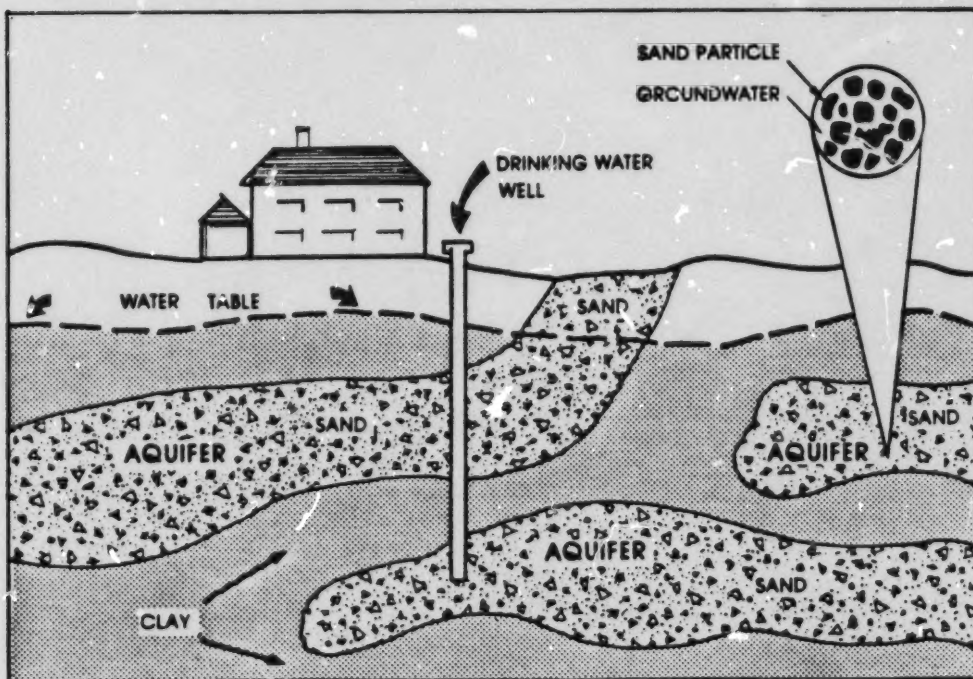


Figure 1-1

Groundwater Is Stored In Aquifers Underneath The Earth's Surface

Source: East Michigan Environmental Action Council

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and is found between the particles (see Figure 1). The character of groundwater can be illustrated by using a glass filled with dry sand. The glass of dry sand appears full. However, when water is poured into the glass, it is found that the glass is not really full. The water fills the spaces between the sand particles--a considerable amount of water can be added to a glass that is already "full" of dry sand. An estimated 10-15 percent of a cup of sand is actually pore space.

Oakland County's groundwater is found in sands left by the continental glaciers which began retreating from this area 14,000 years ago. The glacial material left behind is called glacial drift, and in Oakland County is approximately 250 feet thick (thickness varies from place to place). Glacial drift material includes sandy soils, clay soils, and many variations. Usable groundwater is stored in the sandy soil areas.

All groundwater was at one time rain or snow. When rain and melted snow seep into the ground, the water can pass through the soil and reach areas of sand and gravel where the water is stored. Much of the groundwater used by Oakland County residents originates from the land surface within a short distance of each home.

Oakland County has an abundant source of groundwater, found in many different locations at different depths. The challenge for the future is to protect the quality of Oakland County's groundwater.

The Water Cycle

The water cycle is the continual exchange and flow of water between the atmosphere, the surface of the earth, and underground areas (see Figure 1-2).

When rain falls, a portion of the water is intercepted at the surface of the ground; a portion runs off the surface and reaches streams, lakes, and wetlands; a portion infiltrates into the ground; and a portion evaporates.

Although the balance between surface runoff, surface storage, evaporation, and infiltration vary for different rainstorms and locations, a generalized picture for Oakland County may be described. For every 30 inches of rain which falls in Oakland County, approximately 9 inches (30 % of the total) becomes surface runoff or infiltrates into the ground. A substantial portion of the rainwater (70% of the total) reaches the atmosphere through evaporation or evapotranspiration (see Figure 1-3).

A more detailed examination of the water cycle reveals a series of processes which occur when rain falls or snow melts.¹ When rain falls, it encounters aboveground objects such as plants, trees, and buildings. These surfaces catch and retain the moisture for a period of time (infiltration storage). For example, it is often completely dry under a tree after a light rain because leaves of the tree have intercepted the rainfall.

As rain continues, storage areas fill up and water drips to the ground surface where it is trapped in swales and depressions on the surface

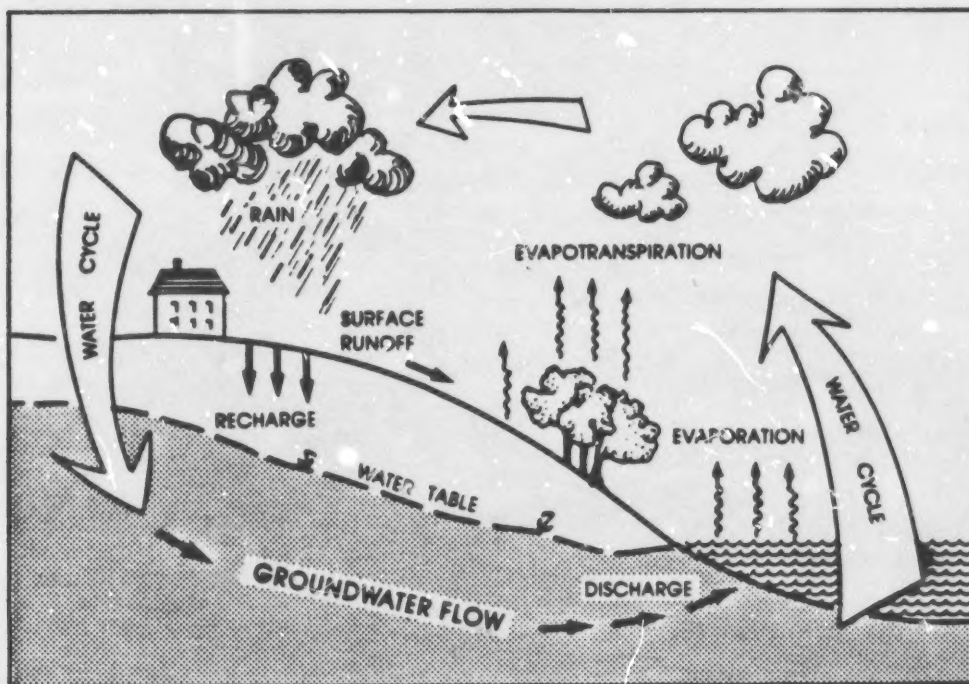


Figure 1-2

The Water Cycle

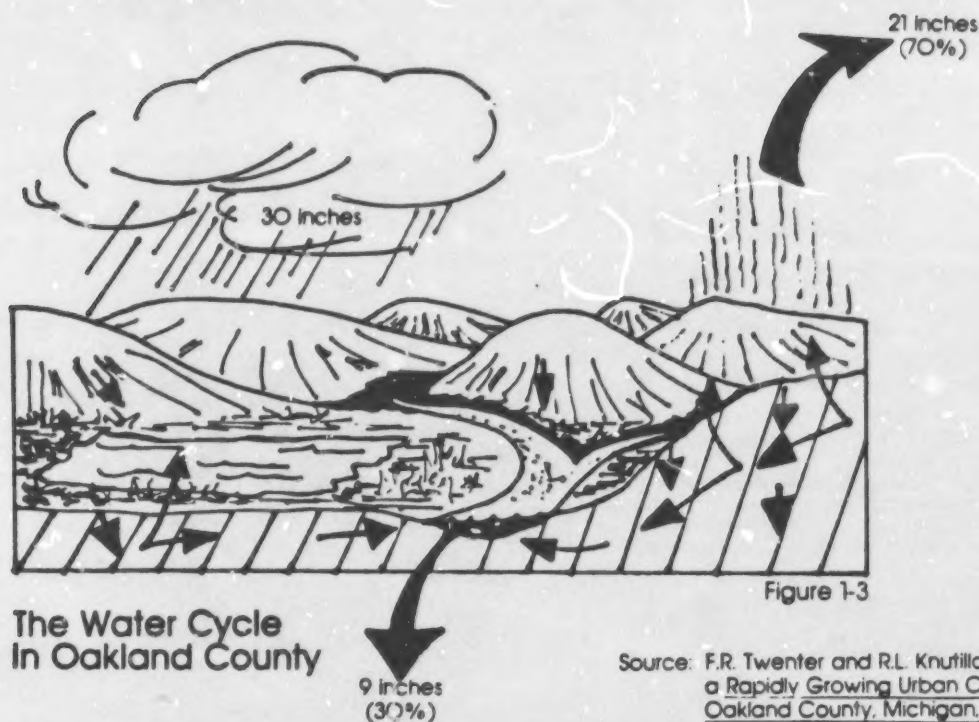
Source: East Michigan Environmental Action Council

of the ground (surface storage). Shallow depressions may then become filled and the overflowing water may run downhill (overland flow). At the same time, moisture on the surface of the ground and the aboveground surfaces is returning to the air in the form of vapor (evaporation).

Some water also reaches the atmosphere through plants (transpiration). Plant roots absorb water from the soil, and the water passes through plant stems or trunks through the branches and the leaves where most of the evaporation takes place. On a vegetated area of ground, it is not possible to separate water which evaporates from water which transpires, and the term evapotranspiration is used to refer to loss of water from the soil due to both processes.

If the ground surface is not frozen, rainwater may seep into the soils (infiltration). Tiny openings between soil particles provide passage to the liquid water as it seeks lower soil levels. These same openings also permit the return of soil moisture to the air through evaporation, a process which occurs rapidly when sunlight shines on open soil.

If the surface is sealed or nearly sealed (such as with pavement or other impervious materials) neither of these two soil processes can occur to any significant extent. The rate of infiltration depends on the nature of the soil material, the type and density of the surface vegetation, and the amount of moisture already in the soil. Dry, sandy soils without vegetation have a much faster infiltration rate than wet clay soils. The larger spaces between the pores in the sandy soils permit easier movement of moisture than do the very small pores in clay soils.



Under the influence of gravity, water may flow rapidly down into deeper soil layers through the larger openings between soil particles. But water may also flow slowly downhill, uphill, or sideways under the influence of capillary action (capillarity) which is the tendency of liquids to adhere to solid surfaces (surface tension). Liquid water may continue to flow downhill and eventually reach the saturated zone (groundwater) or it may emerge from the side of a slope (interflow) and enter a stream or lake.

The process of water reaching the groundwater is called groundwater recharge. In Oakland County, upland areas are principally areas of groundwater recharge. After water reaches the water table and enters the groundwater zone, it moves slowly downward and towards lowland areas. Groundwater movement and flows are very slow—usually only a few inches or feet each year. Discharge areas are the places where water moves into surface waters, such as lakes, streams, and wetlands (see Figure 1-4).

The configuration of the land surface influences the water cycle. When the terrain is rolling, there is less opportunity for infiltration or evapotranspiration to occur before water runs off the surface through overland flow. In contrast, a flat terrain encourages infiltration, and evapotranspiration has more time to occur before runoff begins (see Figure 1-5). The character of the terrain also influences the depth of the water table.



Stormwater Runoff Flows

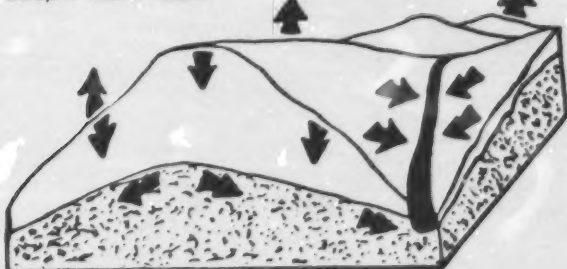
Source: Based upon W.M. Marsh and J. Dozier, Landscape: An Introduction to Physical Geography, Addison-Wesley, Reading, Massachusetts, p. 183, Fig. 13.7.

How Does Groundwater Contamination Occur?

Groundwater contamination occurs when water infiltrates into the ground and transports substances to the groundwater zone. Chemicals on or under the ground surface may be carried by the movement of water through the soils until they reach groundwater. The pathways and movement of chemicals are varied, however, reflecting the type of material and the conditions in the environment.

The fate of chemicals in the environment depends on many different factors.² Insoluble solids (such as paint sludges) will generally remain on the soil surface. Soluble solids (such as salt) will dissolve with rain and either run off with the surface waters, or enter the soil, or both.

More runoff, less recharge, less evapotranspiration and deeper water table



Less runoff, more recharge, more evapotranspiration and shallower water table



Figure 1-5

The Configuration Of The Land Surface And The Water Cycle

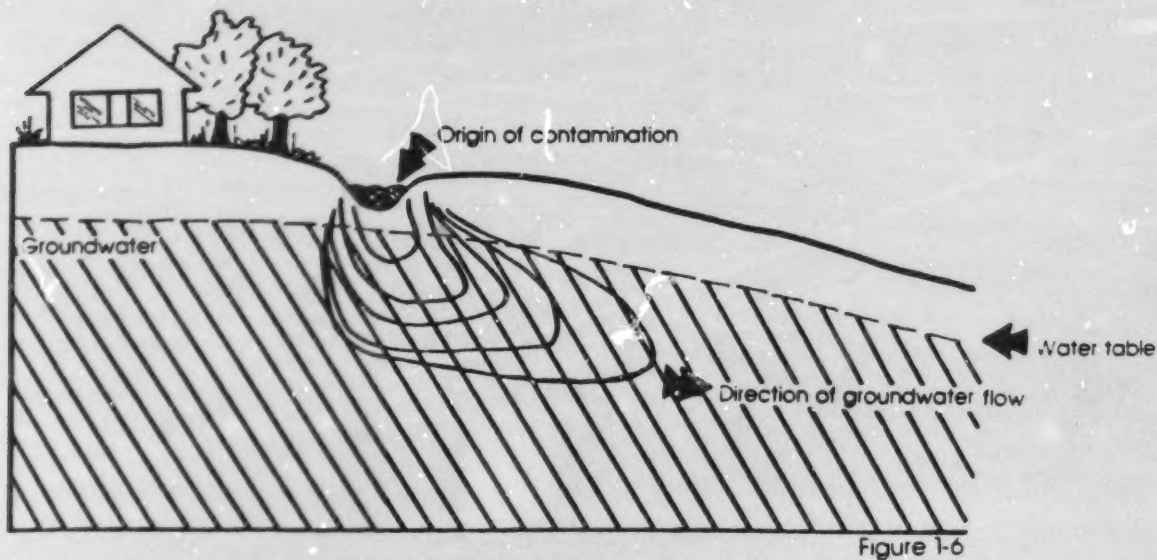
Source: R.R. Twenter and R.L. Knutilla Water for a Rapidly Growing Urban Community - Oakland County, Michigan, p. 23

Organic liquids (such as gasoline and thinners) may undergo a more complex series of changes. If volatile, these liquids will evaporate. If they are not volatile, or if applied in large or concentrated amounts, they may penetrate the surface soils. If the upper soil layers become saturated, these liquids may eventually flow downward into groundwaters.

Slow degradation of most organic chemicals will occur in the upper soil layers, especially if adequate light and air are present. But as the liquids reach lower soil layers, decomposition is less likely. Thus a steady, concentrated source of an inert material (such as a leaky oil or gasoline tank) can eventually contaminate deep groundwaters.

Once in the groundwater, contaminants will move at rates varying from a fraction of an inch to a few feet per day.³ Under idealized conditions (assuming uniform groundwater conditions) an elliptical plume of contamination with well-defined boundaries will be formed (see Figure 1-6). The plume typically enlarges as it travels. Movement and dispersion of the contaminant are affected by the solubility of the contaminant, the density of the contaminant, the geologic formation through which it is moving, and the reactive nature of the contaminant. The plume continues to move with groundwater flow unless it is blocked. The plume may eventually reach points of groundwater discharge such as streams, lakes, and wetlands.

Groundwater contamination may result from natural contaminants, waste-disposal practices, and other sources due to human activities.⁴ Natural contamination is caused when rainwater seeping through the soils picks up naturally-occurring minerals and salts. It is contamination from waste-disposal practices, accidental spills and leaks, and many other "unnatural" factors, however, which has created most of Michigan's groundwater pollution.



Enlarging Plume of Groundwater Contamination

Source: East Michigan Environmental Action Council

Understanding Stormwater Runoff

Although groundwater is under the ground and not visible, the threats to groundwater are often visible on the earth's surface. Citizens who are concerned about protecting their own groundwater supplies will want to be alert for potential threats to groundwater in their homes and neighborhoods. Because stormwater runoff (carrying pollutants) flows overland or downstream, a watershed perspective is also important.

A watershed (also called a drainage basin) is the geographic area from which water in a particular stream, river, or lake originates. All lands in the watershed drain toward the stream, river, or lake. The entire watershed can contribute sediments and other pollutants to the water body (see Figure 1-7).

When rain falls on the land, it may pick up chemical contaminants and flow into lakes and streams in the watershed or enter groundwater. Surface water and groundwater are interconnected in Oakland County; it makes sense to keep contaminants away from both surface water and groundwater (see Figure 1-4).

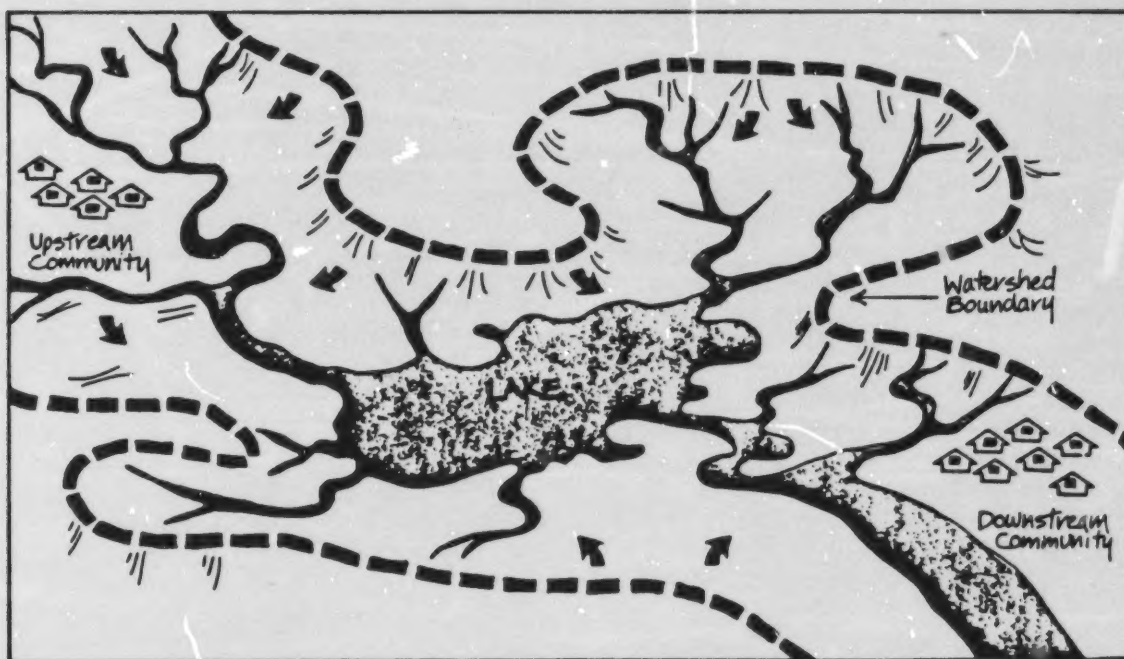


Figure 1-7

Watershed Drainage Patterns

Source: E.W. Say et. al. *Inland Lake Protection in Northern Michigan*. University of Michigan Biological Station, p. 21, redrawn by the Southeast Michigan Council of Governments, 1980

Water Use in Oakland County

Oakland County communities located in the southeast quadrant of the county obtain their water through the Detroit water system. The Detroit water system provides a regional, centralized water system with service to the City of Detroit and many suburban communities. Detroit system water is taken from two intake points on the Detroit River, and one intake point on Lake Huron. Similarly, the City of Detroit owns and operates a centralized wastewater treatment facility, and provides service in Southeast Oakland County.

North and West Oakland County communities depend on groundwater as a drinking water source. In some cases, villages, cities, or subdivisions are served by community wells which provide water to a number of homes and businesses. In most communities, however, groundwater is pumped from individual wells to service one business or home.

The following communities in Oakland County depend upon groundwater as a source of drinking water:

<u>Townships</u>	<u>Villages</u>	<u>Cities</u>
Addison	Clarkston	Auburn Hills (portions)
Avon (portions)	Holly	Novi (portions)
Brandon	Lake Orion	Walled Lake
Commerce	Leonard	Wixom
Groveland	Milford	
Highland	Ortonville	
Holly	Oxford	
Independence	Wolverine Lake	
Lyon		
Milford		
Oakland		
Orion		
Oxford		
Rose		
Springfield		
Waterford (portions)		
White Lake		

Groundwater serves many purposes in the home and business locations:

Home uses of groundwater:

Drinking and cooking
Bathing
Dishwashing/clothes washing
Toilet flushing
Lawn sprinkling
Car washes
Heat pumps

Business and industry uses of groundwater:

Drinking and cooking
Washing
Cleaning and running equipment
Industrial cooling
Livestock (agricultural businesses)

Based on a 1980 water use study in the Village of Milford, the "average" person in Milford uses 50 gallons of water each day for domestic uses. An additional 25 gallons per person are used by businesses and industry. Since Milford is not an industrialized community, it is estimated that the total per person use of groundwater in Oakland County (for home and business use combined) is between 75 and 100 gallons per day.

Actual use of water in a home varies significantly among households. For example, an elderly couple with no children may use only 25 gallons of water each day. In contrast, a family with three teenagers might use 160 gallons of water each day. Actual water use in a household can be determined from water meters in communities where centralized water supply systems are available.

Domestic use of water increases significantly during the summer months. Water use in the Village of Milford provides a typical picture for communities without extensive industrial use. Water use during the months of June and July is more than double the volume used during January and February (see Figure 1-8). Lawn sprinkling and car washing activities probably account for a substantial amount of the difference.

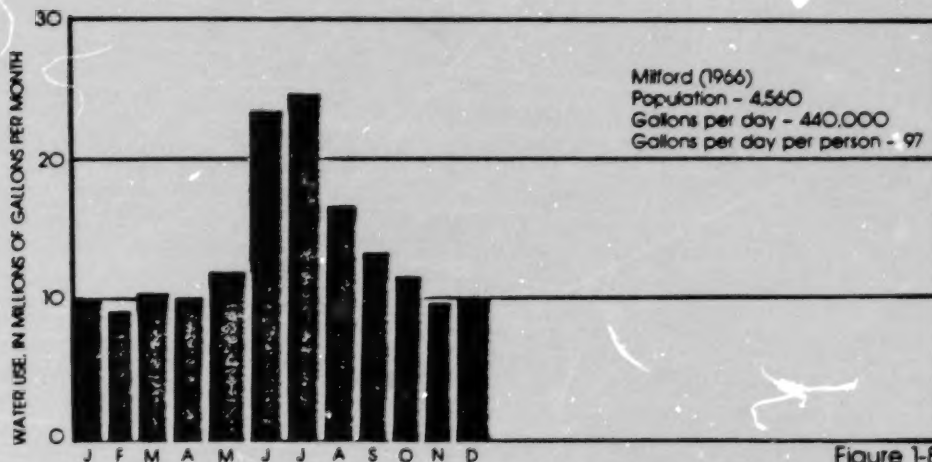


Figure 1-8

Monthly Variations in Water Use-Milford Village

Source: F.R. Twenter and R.L. Knutilla, Water for a Rapidly Growing Urban Community - Oakland County, Michigan, p. 12.

Household use of water can be measured in several different ways. One approach is to measure the amount of water used for each fixture or appliance for each use. An alternative approach is to measure the amount used for each fixture or appliance each day. Some appliances, such as dishwashers, laundry uses, and water softeners are not used daily by all families.

One study of household use of water in 1978 reported the following:⁵

Water Use Per Occurrence:

<u>Toilet:</u>	15.1 liters (4.0 gallons)
<u>Laundry:</u>	127 liters (33.4 gallons)
<u>Bath/Shower:</u>	81 liters (21.3 gallons)
	(most showers generate 5 gallons of water per minute)
<u>Dishwasher:</u>	47.2 liters (12.4 gallons)
<u>Water Softener:</u>	Variable, depending on the unit

Frequency of Occurrence:

<u>Toilet:</u>	2.29 uses/person/day
<u>Laundry:</u>	0.31 uses/person/day
<u>Bath/Shower:</u>	0.47 uses/person/day
<u>Dishwasher:</u>	0.39 uses/person/day
<u>Water Softener:</u>	0.03 uses/person/day

As with all aspects of water use, variations for different households can be significant.

If a household has a water meter, or receives a water and sewerage bill which reports water use, specific and accurate calculations of household water use over a period of time can be made.

In-the-home estimates can be made for several types of fixtures:

Measuring shower water: Using a five-gallon bucket, collect the shower water during a one-minute interval. Then time the length of a shower, and calculate the total quantity of water used.

Measuring toilet water: Measure the depth of water in the tank, and multiply by the width and length of the toilet tank. The water in the tank is flushed down the toilet after each use.

Other measurements of household appliances such as a clothes washer may be made by measuring the capacity of the machine, observing the amount of water in the machine for each cycle, and counting the number of cycles.

Alternatively, using the "average" figures reported here, a student could make his or her own quantity measurements of water use in the home. Being aware of groundwater use is the first step toward recognizing the importance of protecting groundwater quality.

¹Description of the water cycle prepared by Dr. Paul Tomboulia, Chairman, Department of Chemistry, Oakland University.

²Information on groundwater contamination processes prepared by Dr. Paul Tomboulia, Chairman, Department of Chemistry, Oakland University.

³Veronica Pye, Ruth Patrick, and John Quarles, Groundwater Contamination in the United States, University of Pennsylvania Press, Philadelphia, 1983, p. 51.

⁴Ibid.

⁵Information from University of Wisconsin study, "Management of Small Waste Flows, 1978," as reported by Mark J. Hampton, Purdue University, 1983.

**INTRODUCTION TO GROUNDWATER
QUALITY
Classroom Activities**

Introduction to Groundwater Quality Classroom Activities

The classroom activities and projects outlined in this section have been developed to be part of a basic science unit on groundwater quality. The activities have been used and piloted in several classrooms and changes have subsequently been made to simplify and clarify the activities.

The following activities are included:*

#1: WHAT IS GROUNDWATER?

Concepts: Definitions of groundwater and the water table.

#2: WATER INFILTRATION IN SOILS

Concepts: Water (and any contaminants that it carries) moves through different soils at different rates. Sandy soils have larger particles and allow water to seep through more quickly than clay soils. Clay soils serve as a barrier to water and contaminants carried by the water.

#3: SIMPLE VERSION OF A WELL

Concepts: Groundwater used for drinking is pumped from the ground by a water well. Groundwater may contain contaminants which are not visible or apparent.

#4: MOVEMENT OF GROUNDWATER AND CONTAMINANTS

Concepts: Contaminants at the surface of the ground can move slowly underground through soils and reach groundwater.

Contaminants spread outward from the point of origin, forming a plume which "points" to the source of origin. A small amount of a contaminant can ruin a large quantity of groundwater.

Some contaminants are visible, while others are not visible in water. Special laboratory tests may be needed to determine whether groundwater is contaminated.

Activities #1, #2, and #3 are demonstrations for the classroom. Understanding can be enhanced by involving students in the demonstrations and the observations of the results. Activity #4 may be used either as a demonstration or a classroom project.

*Activities developed by Dr. Charles Cubbage and piloted by Jim Leh, Fenton Junior High School.

#1 WHAT IS GROUNDWATER?

Concepts:

1. Definition of groundwater: Water found within the saturated pores of the ground.
2. Definition of water table: Area of line dividing the saturated soils from the unsaturated soils. Water found above the water table is called soil moisture.

Materials:

Two clear plastic cups (4-6 oz.)

Pea gravel to fill a cup (aquarium chips may also be used)

Sand to fill a cup halfway

Water

Note: Sand taken from a parking lot or sand box may be used. A wire mesh screen is useful for removing large stones.

Set-up:

Fill cup #1 with pea gravel, then fill with water halfway to top.
Fill cup #2 half full with sand.

Procedure:

A. Definition of Groundwater

Study the cup with pea gravel. The pieces of stone represent soil particles, and the water between them (in the pore spaces) is groundwater. The upper surface of the water is the water table. (Mark the water table line on the cup with a colored marker or colored tape.)

B. Definition of Water Table

1. Explain that the sand represents soils under the ground. Pour in enough water to cover 2/3 of the soils.

Note: The sand is porous, since the water went into the sand without raising the level of the sand in the cup or overflowing. The water is flowing into the pores between the sand particles.

2. Poke a hole in the sand with your finger to observe the location of the water table. The hole is like a miniature lake.
3. Note that soils above the simulated water table are "wet," but not saturated. Similarly in the ground, only a portion of the rainfall on the surface of the earth reaches the water table. (See discussion of water cycle in the text.)

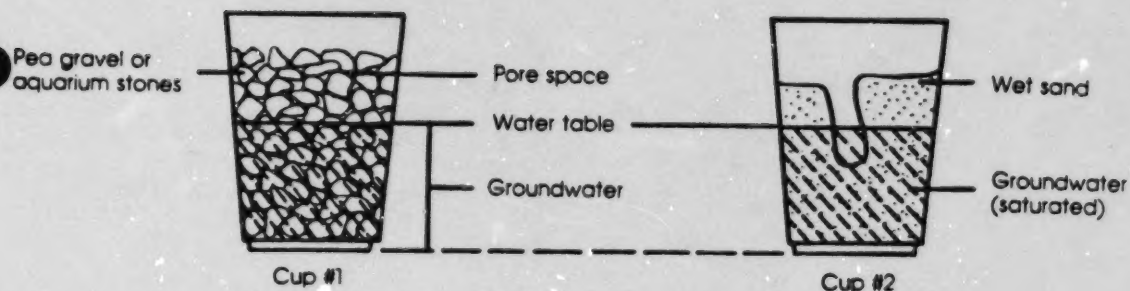
Discussion Questions:

Definition of Groundwater (cup with pea gravel) -

1. If the cup was full of gravel, where did the water go?
2. What does the water in the cup represent?
3. What is the upper surface of the water called?
4. 70% of the water that falls as rain or snow does not reach the water table. What happens to it? (three things).

Definition of Water Table (cup with sand) -

1. What happens when you put your finger into the sand? Why?



#2: WATER INFILTRATION IN SOILS

Concepts:

Water (and any contaminants that it carries) moves through different soils at different rates, depending on the type of soil and other factors. Sandy soils have larger particles and allow water to seep through more quickly than clay soils. Clay soils serve as a barrier to water movement and contaminants.

Materials:

Four clear plastic cups

Four pencils

Two pieces of nylon stocking, paper towel, or coffee filter to serve as screens in the bottom of the cups

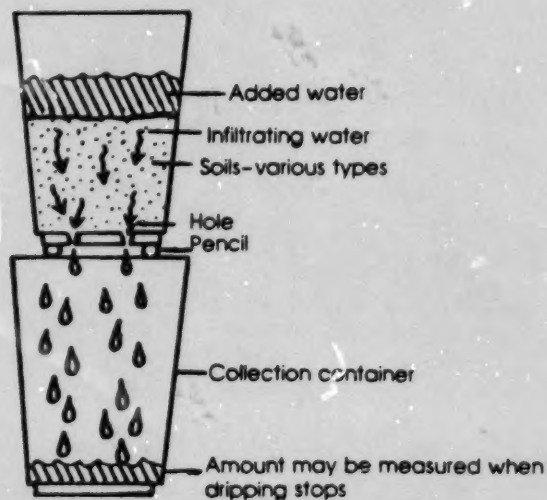
Set-up:

Two similar set-ups with different soil types should be planned.

Drill small holes in the bottoms of two of the plastic cups. The holes should be large enough to let water run out freely. Set each cup with holes over an empty cup, using two pencils as supports (see illustration below). (Styrofoam cups may be substituted if clear plastic cups are not available.)

Place the screen material (nylon stocking, paper towel, or coffee filter) in the bottom of each cup with holes and fill with soil or sand. One cup should be filled with sand, or sandy soil. The second cup should be filled with clay soil. Fill the cups 1/3 full. Gently tap the containers to settle the soil, but do not pack them tightly.

Soils and sand should be dry. If necessary, spread out the sand or soil on newspaper and let it dry overnight before using the demonstration.



Procedure:

1. Carefully measure $\frac{1}{2}$ cup water and pour into each of the two top cups. It is important to pour the same amount of water into each of the two setups so that a comparison can be made on the amounts of water held by different soils as well as the rate of flow through the soils (infiltration rate).
2. Set the cups aside for $\frac{1}{2}$ hour. At the end of $\frac{1}{2}$ hour, measure the amount of water in the bottom of each cup (if any). Record the quantity.
3. Set the cups aside again for $\frac{1}{2}$ hour. At the end of the second $\frac{1}{2}$ hour measure the amount of water in the bottom of each cup (if any).
4. Discuss the results.

Note: Sandy soils are porous and allow water (and other liquids) to seep through at a rapid rate.

Clay soils are very dense, with small particles and small pore spaces. Depending on the type and amount of clay soil, movement of water will be very slow. In some cases, it may take hours before water begins to pass through clay soils. If clay soils are packed tightly, water may never drip through.

Discussion Questions:

1. Why did water infiltrate quickly through sand (or sandy soil) and slowly through clay soils?
2. Did all of the water poured into either of the cups drip through? What are the implications for groundwater recharge? (Review the water cycle and groundwater recharge.)
3. If an accidental chemical spill occurred in an area with sandy soils, would there be a potential for groundwater contamination? If the same spill occurred in an area of clay soils, would you expect to see any difference?

In addition to soil types, what other factors might influence the likelihood of groundwater contamination occurring? (See discussion of flow of contaminants in the text).

Note: A demonstration of soil infiltration may also be done out-of-doors using coffee cans with the tops and bottoms removed.

Push the cans halfway into the soil (use several different locations with different types of soils). Pour a known volume of water into the can. Record the length of time needed for the water to penetrate the soil. Compare the results among sites and discuss the results.

#3: SIMPLE VERSION OF A WELL (Introduction to Activity #4)

Concepts:

Groundwater used for drinking can be pumped from the ground by a water well. The groundwater may contain contaminants which are not visible.

Materials:

Spray top or pump from cosmetic or window cleaner bottle (or a spray can used to water plants)

A plastic cup with marbles, stones, or pea gravel (similar to demonstration #1)

Vinegar, lemon juice, or powdered lemonade mix (with or without sugar)

Acid indicator, such as pH paper (wide range) or Bromocresol Green

Set-up and Procedure:

To demonstrate the well with plain water:

Put pea gravel in cup and fill halfway with water.

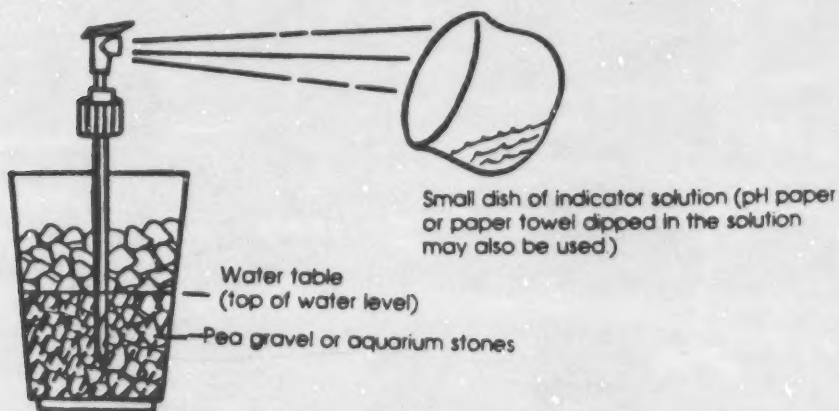
Insert the spray pump (representing the water well) and spray the water.

To demonstrate groundwater contamination:

Before the beginning of the class, dissolve small amount of vinegar, lemon juice, or powdered lemonade in water (separate cup). (A teaspoon is usually enough.)

Pour the "vinegar" water into the cup with pea gravel and insert the pump. "Spray" the water into a small glass dish with an indicator solution such as Bromocresol Green.

(Paper towel dipped into the indicator solution, pH paper, or litmus paper may also be used.)



#4: MOVEMENT OF GROUNDWATER AND CONTAMINANTS

Concepts:

Contaminants at the surface of the ground can move slowly through soils and reach groundwater.

Contaminants spread outward from the point of origin, forming a plume which "points" to the source of origin. A small amount of contaminant can ruin a large quantity of groundwater.

Few contaminants are visible in water, while most are not. Special tests are needed to determine whether and to what extent groundwater is contaminated.

Materials:

Clear plastic shoe box filled with 1" layer of sand (see illustration)

Liquid food coloring (red, blue, or green)

Powdered lemonade mix (with or without sugar)

Sprinkling can or spray bottle to "rain" on the sand in the box without washing the sand away.

Four plastic straws, cut in half

Acid-base indicator solution, such as Bromocresol Green

Note about indicator solutions:

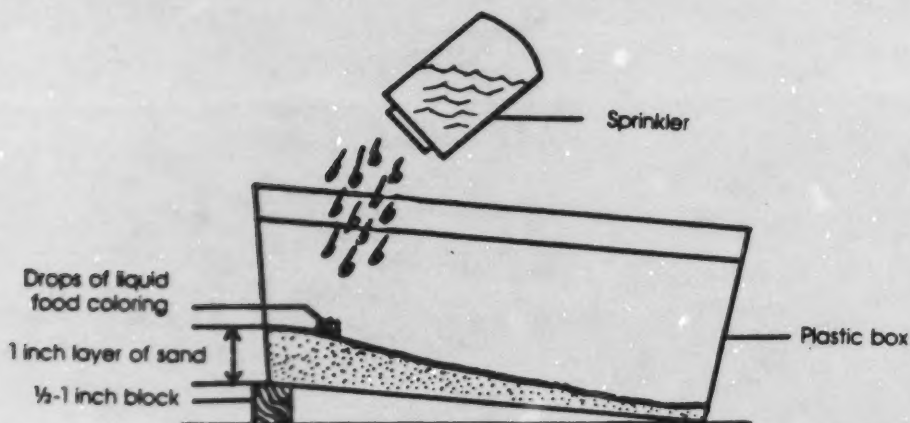
Indicator solutions are useful for showing water which has been contaminated with an acid material (such as lemonade or vinegar). The list below includes some common indicators which will shift color between "normal" groundwater pH and the pH set-up with the lemonade contaminant.

pH RANGE

Indicator	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Bromocresol Green	yellow(-----)blue									
Methyl Red	red(-----)yellow									
Bromothymol Blue	yellow(-----)blue									
Phenol Red	yellow(-----)red									

Bromocresol Green is a readily-available indicator with a pH detection range of 3.8-5.4. At the low end of the range (more acidic) the solution (which appears dark green) turns yellow. At the upper end of the range, the solution turns blue.

Bromocresol Green is often found in high school science laboratories. A solution of 100 ml may be ordered through "Science and Things", a science supply store in Farmington Hills for about \$5.00. (Telephone 313/478-8389.)



Set-up and Procedure:

To demonstrate visible movement of contaminants:

1. Layer sand in the shoe box so that it is no more than 1-2 inches deep at the deepest end. (Block up the end $\frac{1}{2}$ inch).
2. Place about 5 or 6 drops of liquid food coloring on the surface of the sand (representing a chemical contaminant).
3. "Rain" on the contaminant, using the spray bottle or sprinkler and water. The "rain" should be light, so that the food coloring is diluted and seeps into the sand without just running off the top of the sand. (A simple sprinkler can be made by punching small holes in the top of a jar with a screw-top lid.)

It may be necessary to "rain" on the sand for 5 minutes to move the food coloring to the bottom of the shoe box where the plume of contamination will be visible. If wet sand is used, the contaminant will move more quickly. If erosion of the sand in the shoe box is a problem, a thin layer of pea gravel can be spread on top.

4. Every 2-3 minutes check the bottom of the plastic shoe box for evidence of color. After about five minutes, a plume of color will usually begin to appear. Draw the shape of the plume on the blackboard.
5. Check the size and shape of the plume after $\frac{1}{2}$ hour and discuss the results. The plume should be broad and fanlike, pointing to the point of origin.

(MOVEMENT OF GROUNDWATER AND CONTAMINANTS, CONTINUED)

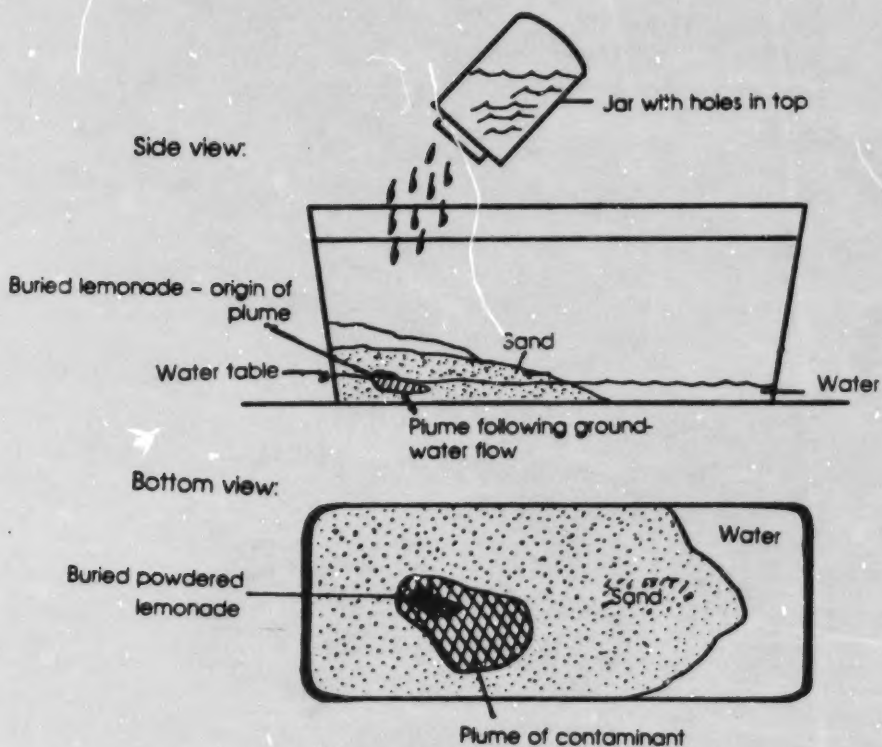
To demonstrate invisible contaminants in groundwater:

1. Fill a clear plastic box with about 1 inch of sand. Smooth off the top of the sand so that it is higher at one end. (Note: If wet sand is used, the contaminant will travel more quickly than if dry sand is used).
 2. Block up the end of the box with the 1 inch sand depth (a block of about 1/2 - 1 inch works well.)
 3. Make a small depression in the sand at the upper end and add 1/2 teaspoon of powdered lemonade. Cover the hole with sand. This is your contaminant.
 4. Set up 12 strips of paper towel soaked in indicator solution, or lay out a strip of pH paper (can be taped to surface of desk). The indicator solution (or pH paper) will be used for "testing" water from different locations of the plastic box.
 5. With a sprinkling can, "rain" on the upper end of the box so that the sand gradually becomes saturated. Add water slowly so that there is no runoff. Keep watering until the rain reaches the lemonade and carries the lemonade downward and toward the other end of the box. (The time will vary with the amount of water and the depth of the sand. These factors could be systematically varied to illustrate variations in contaminant flows).
 6. Using pieces of plastic straw, remove a plug of sand (and water) from the box. Drop the wet sand on the paper towel soaked in indicator solution (or onto pH paper). If the indicator solution turns yellow, you know that a location of "contaminated groundwater" has been found).
 7. Use the worksheet to record the results of each test well. Take a total of twelve test samples and note the results.
- Note: If the Bromocresol Green indicator solution turns blue rather than yellow, the lemonade has probably been diluted to the point that the pH of the water is being recorded. The project works best when the lemonade stays sufficiently concentrated to change the color from dark green to yellow.
8. A fresh straw should be used each time, or the same straw washed out before reuse. Following the project, the sand can be washed out and dried on newspaper for reuse.
 9. Students may assist the demonstration by taking turns removing plugs of wet sand and testing the samples in the indicator solution. Students may work with their own plastic boxes, or in groups of 3-4, following the demonstration.

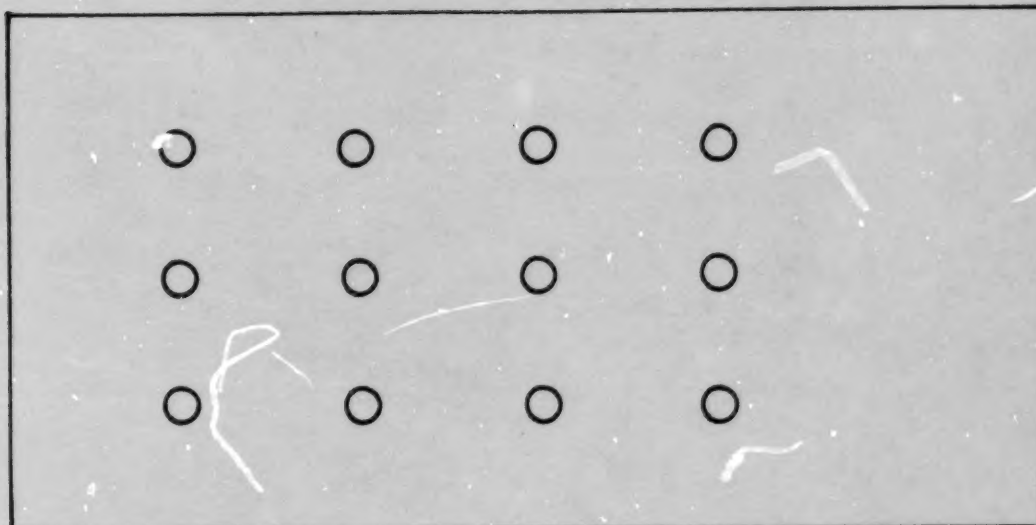
(MOVEMENT OF GROUNDWATER AND CONTAMINANTS, CONTINUED)

Discussion questions:

1. What makes the contaminant move away from where it was buried?
2. Why did the contaminant move in that direction?
3. What factors underground might influence the movement of contaminants? (in the real world)



LOCATING GROUNDWATER CONTAMINATION

Instructions:

1. Take a sample of sand and groundwater from each test well location indicated above.
2. "Test" the groundwater at each location for contamination.
3. Record the results on the worksheet above:
+ = contamination found
- = no contamination
Record the results directly on the test well location.
4. Based on the results of the testing, sketch the shape of the plume of contamination.
5. Is the number of "test well" locations sufficient to determine the extent of the plume of contamination?
6. If you were to select three additional "test well" locations, where would they be placed? Indicate your proposed locations with the letter "T" on the worksheet.
7. "Test" the groundwater at each new test well location and record the results. If the results show contamination, mark the well T+. If the results show no contamination, label the location T-.
8. Are more test wells needed to show the extent of the plume of contamination?

**AWARENESS AND MANAGEMENT
OF HOUSEHOLD HAZARDOUS
MATERIALS**

Awareness and Management of Household Hazardous Materials

Poisons in the Home: Household Hazardous Materials

Some materials which are commonly found in the home can be poisonous for children, adults, and pets.

Over the course of a year, the average home will contain 45 aerosol sprays, 2 dozen bottles and containers of cleaners, and several insect killers and repellents.¹ Motor vehicle products, paints and paint thinners, solvents, spot removers, polishes, and others must be added to the list of hazardous materials in the home.

Both the quantity and the variety of materials pose hazards to health. A few drops of a cleaner may do little harm, but an open can evaporating in a confined space over a period of time may cause illness. Many products, including cosmetics, drugs, aspirin, alcohol, and tobacco can seriously harm small children if they are eaten.

Chemists handle chemicals with properties similar to pesticides and oven cleaners, but typically use a laboratory hood to remove fumes and wear rubber gloves for protection. The only advice most homeowners receive is the label on the container and the caution to use the product "with care" and to keep it out of reach of children. Only an alert and informed citizenry can reduce the illnesses and deaths resulting from the misuse of household hazardous materials.

Disposal of household hazardous materials is a second concern--a concern which has received attention from public health and environmental specialists only in the last several years. Household hazardous materials, if poured or buried in the back yard or dumped into the drain or toilet in quantities, can infiltrate through the soils and reach groundwater. Several types of household hazardous materials, including motor vehicle products, insecticides, paint thinners and solvents are particular concerns because of their chemical properties.

The theme of this section and the projects for the classroom and home is two-fold:

- .The first step to health and environmental protection is awareness of hazardous materials in the home; and
- .With care, household hazardous materials can be managed to reduce threats to health and groundwater.

The study of hazardous materials in the home may be undertaken as a separate unit, or as part of a more extensive examination of groundwater quality and groundwater protection needs in the community.

What Does Hazardous Mean?

Hazardous materials and wastes are chemical substances which can harm, contaminate, or kill living organisms.

Hazardous materials and wastes have one or more of the following characteristics:

- Toxic: Poisonous, potentially harmful to human health, can cause cancer and birth defects, and can contaminate, harm, or kill fish and wildlife.
- Corrosive: A substance which can corrode storage containers or damage human tissue if it is touched.
- Reactive: An unstable substance which can react if exposed to heat, shock, air or water. Reactions include explosions.
- Ignitable: A substance which can explode, catch on fire, or emit toxic gases or fumes into the environment.

The term "toxicity" refers to the degree to which a substance is poisonous. Every substance has some level of toxicity, although obviously many foods are virtually non-toxic. In contrast, some substances are so poisonous that a single taste can be deadly.

Routes of exposure for hazardous materials include inhalation, ingestion, and skin contact. Although each chemical behaves in a different manner, caution and care should always be taken when handling hazardous materials.

The classroom handout titled "Cookies Aren't the Only Things Little Kids Put in Their Mouths When Grown-ups Aren't Looking" includes a list of common household products. Some of the products on the list, such as rat poison, spot removers, oven cleaner, and drain openers are widely recognized by adults as being hazardous. Other products on the list, such as cleaners, cosmetics, and houseplants may be a surprise. The list in this brochure reflects actual incidents of home poisoning, as reported to the Poison Control Center in Detroit. (For further information telephone the Poison Control Center, (313)494-5711.)

Unfortunately, the concept of toxicity may not adequately point out long-term dangers from repeated chemical usage. Some materials may be only slightly toxic when handled once, but may be long-term poisons. Very little information is available on chronic toxicity because of the difficulty of measuring health effects from low doses over long periods of time.

A second limitation is related to groundwater quality protection. Many different substances can ruin groundwater supplies used for drinking--even if the substance is not on a list of household hazardous materials. Moreover, some hazardous materials, such as drain openers and toilet bowl cleaners, may not be a groundwater threat. Materials such as these

neutralize in the septic system and should not present problems if used as directed. In contrast, solvents and thinners do not neutralize in the septic system and, because of their chemical composition, can move through the soils and reach groundwater. The list of household hazardous materials which are a concern for home safety is different from the list of household hazardous materials which are of most concern for groundwater quality protection.

Hazards from Selected Household Materials

The health danger posed by household hazardous products is directly related to the chemicals in the product. Different types of furniture polish, for example, may have varying chemical characteristics and hazards. It is important to read the label carefully to identify chemicals in the product and instructions for use.

The most highly toxic household hazardous materials available in the store today have warnings and notes of caution. Federal labeling regulations have varied over the past ten years, however; and bottles and cans of materials may not adequately reflect the true safety problems.



Chemical Household Cleaners: The number and type of household cleaners available to the consumer is almost limitless. There are products for almost any individual cleaning job in the home that can be imagined. The following types of cleaners are of particular concern because they contain reactive chemicals: oven cleaners, drain cleaners, bleaches, toilet bowl cleaners, and scouring powders. Special care should be used in keeping these materials separate from each other. Dangerous reactions and explosions may occur if they are mixed together.

More than 22,000 people received hospital treatment in the United States in 1973 for injuries associated with cleaning agents.² Inexpensive, available substitutes which may be useful include soap, baking soda (sodium bicarbonate), vinegar (dilute acetic acid), ammonia, washing soda, and borax.

Typical compounds found in cleaning agents and dangers associated with the compounds are listed on Figure 2-1.

Figure 2-1

TYPICAL COMPOUNDS FOUND IN CLEANING AGENTS

<u>Name</u>	<u>Where Found</u>	<u>Purpose</u>	<u>Dangers</u>
Lye), potassium hydroxide, sodium hydroxide	Oven and drain cleaners	Chemically attack and dissolve organic matter	Extremely dangerous to all parts of body, especially eyes
Ammonia	Oven and window cleaners, wax removers	Chemically attack and dissolve organic matter	Strong concentrations attack skin, eyes, lungs
Sodium tripolyphosphate	Coffeepot cleaners	Water softener and building agent	Strong concentrations attack skin, eyes, lungs
Sodium phosphate	Cleaners, scouring powders	Water softener and building agent	Strong concentrations attack skin, eyes, lungs
Sodium silicate	Dishwashing detergent	Water softener and building agent	Strong concentrations attack skin, eyes, lungs
Sodium metasilicate	Dishwashing detergent	Water softener and building agent	Strong concentrations attack skin, eyes, lungs
Sulfuric acid	Commercial drain cleaners	Chemically attack and dissolve organic matter	Extremely dangerous to entire body
Hydrochloric acid	Drain cleaners, toilet cleaners	Remove stains and deposits	Extremely dangerous to entire body
Phosphoric acid	Denture cleaners, metal cleaners and polish	Remove stains, dissolve rust	Extremely dangerous to entire body
Sodium hypochlorite	Bleach chlorine	Remove color, disinfect	Dangerous to entire body; never mix with anything other than soap or water
Calcium hypochlorite	Bleach chlorine	Remove color, disinfect	Danger to entire body; never mix with anything other than soap or water
Sodium perborate	Oxygen bleach, denture cleaners	Remove color, disinfect	Dangerous to entire body; mildly toxic
Sodium dodecylbenzene sulfonate	Detergent	Dissolve grease and oil	Continued contact removes protective oil from skin

Source: Center for Science in the Public Interest,
The Household Pollutants Guide, pp. 182-183.

Paint Products and Solvents: A solvent is a substance which dissolves another substance. Water is the most common solvent, used for many purposes in the home. Solvents which contain hydrocarbons (in-



cluding petroleum distillates, toluene, benzene, xylene, turpentine, alcohols, methylene chloride, trichloroethane, carbon tetrachloride, fluorinated hydrocarbons, and others) pose special threats to health and the environment. These liquid solvents are used as cleaners for home painting, staining, and varnishing projects, as well as spot removers.

In 1973, nearly 12,000 serious injuries from paint products were reported in the United States. Most of the injuries were from acute poisoning and chemical burns, most frequently damaging the eyes. Children, especially four years of age or younger, are often the victims. Carelessness with open containers, such as when paint brushes are left soaking, is a major cause of injury. Other hazards may arise when solvents are transferred to unlabeled or mislabeled containers.

When using solvents, it is important to read labels carefully, think ahead about how solvents will be used, and know first-aid remedies in case of accidents. Work indoors only when ventilation is adequate. Work outdoors only when weather is suitable--windy weather may create its own hazards. Although many solvents do not have substitutes, it is possible to use water-based paints which do not require volatile solvents.

Household Plants: While plants enhance the home, they may also be poisonous, especially to children. Certain parts of the plant may be safe (or even edible) when other parts may be highly toxic. Leaves of tomato and rhubarb plants, for example, are poisonous and should never be used for brewing herb teas. Elderberry vines grow toxic shoots which children use for blowguns and whistles--with dire results.



Examples of poisonous plants in the home and garden include dieffenbachia (leaves and stems), azalea (berries, leaves, roots, and flowers), foxglove (roots, leaves and seeds), hyacinth (bulb), lily-of-the-valley (roots, leaves, flowers, fruits), mistletoe (berries), narcissus (bulb), philodendron (leaves and stems) and rhubarb (leaves), among others.

In 1974, 6,500 poisonings from plants were reported by American health officials. Many of the poisonings involved small children.

Poinsettia has been the subject of controversy. Although the

30

Society of American Florists has commissioned studies which reportedly demonstrate that the plant is not dangerous, it remains on the toxic list of some medical authorities. While the real truth may be difficult to ascertain, the warning of the New York State Consumer Product Safety Commission should be observed: "...poinsettia leaves, like those of many other plants, may cause varying degrees of discomfort if eaten, and should be placed out of reach of small children."³

Motor Vehicle Products: Gasoline, motor oil, anti-rust agents, degreasers, and other products used with automobiles are toxic and hazardous to the health.



Gasoline is highly toxic, yet it may be carelessly stored and handled in the basement and garage. Some people use gasoline to remove paint from hands and arms and spill gasoline carelessly on the floor. Gasoline consists of hundreds of hydrocarbons, some naturally found in crude petroleum and many others formed by chemical processes which enhance engine performance. Although no-lead gasoline does not have lead, it has a higher level of components such as benzene.

Motor oil is also toxic, and can be harmful to human health. Unused motor oil contains toxic additives. Used motor oil may contain other harmful materials picked up from the engine during use.

Anti-freeze is a particular problem because it has a sweet smell, and can be attractive to dogs and even children. Care must always be taken in using, sealing, and storing motor vehicle products in the basement and garage.

Chemical Pesticides: Insect and bug killers, no-pest strips, and animal flea collars are common household hazardous products. Dangers may come from "old" containers of highly toxic chemicals which are now banned from sale, as well as from products currently available. Approximately seventy percent of the pesticide case reports received in poison control centers across the country involved children under five years of age.



Dangers with pesticide practices include inhalation and poisoning from direct use, vapors and dusts from tree and shrub spraying near the home, home fumigation for roaches and other pests, accidental spillage

in stores where pesticides are sold (spilled material may contaminate food sold in the store), and food contamination from garden or agricultural spraying. Insecticides may not be removed from food products in commercial washing practices.

If it is necessary to use chemical pesticides, homeowners should be alert for potential hazards. Pesticides should be used only when there is an emergency situation and no other method for pest control is available. Specialists in disease control caution about "over-reacting" to a disease or pest infestation. If you think a plant needs pesticide treatment, first identify the cause of the problem. After the problem has been identified, the right product can be selected and properly applied at the right time of the year. Non-toxic alternatives to pesticides are available for some uses.

Current federal regulations require certain information on the labels of household hazardous products, depending on the level of toxicity. The first rule for using household hazardous products is to carefully read the instructions on the label.

Care should always be taken in storing, handling, and using household hazardous materials. The following tips apply to many products:⁵

- .Keep potential poisons out of sight and out of reach.
- .Read labels and follow directions.
- .Don't use or store pesticides or cleaning supplies near food or drink.
- .Keep products in original containers. In case of poisoning, you will need to know what is in the product.
- .Throw away prescriptions and household products you don't use anymore (see suggested disposal practices).
- .If you're using a hazardous product when the phone or doorbell rings, take the product with you.
- .Mop or vacuum floors often to remove dangers from spills.

Routes to Groundwater

When household hazardous materials are used sparingly, according to directions, groundwater threats can be minimized.

Possible routes to groundwater include the following:

1. Septic system: Certain hazardous materials are not broken down in the septic system or the surrounding soils. Groundwater hazards are increased if the septic system is overloaded with water or if the distance between the bottom of the drainfield and groundwater is small.

(Note: Drain openers, chlorine bleach, oven cleaner, and toilet bowl cleaner may be poured down the drain or toilet with plenty of water. These materials become chemically deactivated and do not normally remain hazardous.)
2. Underground fuel storage tank: Leaking underground fuel storage tanks pose threats to groundwater, since small leaks may go undetected. Abandoned, out-of-use tanks (with some fuel remaining in them) pose threats as well.
3. Pit for burying or dumping old materials: Household hazardous materials, including paints, thinners, oil, pesticides, and other materials should not be dumped or buried in the back yard. Hazardous chemicals can be carried by rain waters into the soil where materials may reach groundwater. Spreading of used motor oil on roads for dust control is also not advisable from the standpoint of environmental protection.
4. Sanitary landfill: In many communities, household trash is carried to a sanitary landfill for disposal. It is legal in Michigan to dispose of household hazardous waste in licensed sanitary landfills. However, it is best to limit the amount you discard, since landfills are not designed to handle hazardous materials. To reduce groundwater threats, keep small amounts of leftover materials in their original containers and wrap with newspapers or plastic bags. (See the listing "Household Materials Most Likely to be Groundwater Hazards--Tips for Disposal" included in the materials for teachers.)

Based upon the chemical characteristics of hazardous materials and probable disposal routes, the following household hazardous materials are the most likely to be groundwater hazards:⁶

Fuel Oil	Paint
Used motor oil	Varnish, stains
Used anti-freeze	Thinners, solvents
Used brake fluid	Wood preservatives
Insecticides	Kerosene
Weed killers	Gasoline

Certain household hazardous products which may be hazardous to human health, such as household cleaners, do not pose significant groundwater quality threats. Drain openers, chlorine bleach, oven cleaner, and toilet bowl cleaner, for example, become chemically deactivated and diluted when put into the drain or toilet with plenty of water.

Proper Disposal of Household Hazardous Materials

Finding safe and acceptable places to dispose of household hazardous materials is not always easy. The best approach is to use up materials according to directions, or share leftover products with friends or neighbors who can put the material to use. Try not to buy hazardous materials unless alternatives are not available.

The classroom handout titled "Household Materials Most Likely to be Groundwater Hazards: Tips for Disposal" lists recommended disposal practices and is intended as a reference guide.

Used oil recycling should receive special attention, since it is a way to re-use a household hazardous material. Used motor oil can be carried to gasoline service stations or automobile dealers which have their own tanks for storing used motor oil. Many stations accept used oil as a service, provided that homeowners are careful about spillage.

Gasoline service stations then sell their used oil to a waste oil hauler for a small charge (often 20 cents to 30 cents a gallon). The waste oil haulers transport the oil to facilities which recycle the oil. In some cases, a reclamation or reprocessing process is used which makes the oil suitable for industrial use (re-use as oil or burning as a fuel). Re-refining requires a more extensive cleaning process before the oil can be packaged and re-used. Several waste oil haulers in Southeast Michigan transport oil to Indiana and Illinois re-refining facilities.

Wayne Disposal Company, Ypsilanti, Michigan, is a licensed hazardous waste disposal facility which will accept household hazardous waste from individual citizens as a public service. Disposal at a hazardous waste disposal facility is environmentally a better alternative than sanitary landfills not designed to handle hazardous waste. For further information, telephone Wayne Disposal Company at (313)697-7830.

For advice on individual hazardous waste disposal problems, contact the

Oakland County Health Division, (313)858-1312, or the Hazardous Waste Division, Michigan Department of Natural Resources, (517)373-2730. The PEAS number (Pollution Emergency Alert System) is a 24-hour toll-free number for use in pollution emergencies: 1-800-292-4706.

Awareness of household hazardous materials is the first step leading to proper use and disposal practices. It is just now being realized that citizens may be creating their own groundwater contamination. Many potential problems can be avoided if they are given some advance thought.

¹Center for Science in the Public Interest, The Household Pollutants Guide, Anchor Books, 1978. (Although now out of print, this book is an extremely useful reference with information about the chemical composition and hazards associated with various household products. It may be available at area libraries.)

²Ibid., p. 187.

³Ibid., p. 253.

⁴Ibid., p. 129.

⁵"Cookies Aren't the Only Things Little Kids Put in Their Mouths When Grown-ups Aren't Looking," brochure published by the East Michigan Environmental Action Council, 1983.

⁶List prepared by Dr. Paul Tombouljian and Alice Tombouljian for the East Michigan Environmental Action Council, 1984.

Awareness and Management Of Household Hazardous Materials

Classroom and Home Activities

The worksheets, classroom handouts, and home activity sheets which follow are designed to foster an understanding of household hazardous materials and their proper management to prevent threats to groundwater.

The recommended sequence is as follows:

Day 1 - classroom: INTRODUCTION TO HOUSEHOLD HAZARDOUS MATERIALS
HOUSEHOLD CLEANERS - READING LABELS

Teacher defines household hazardous materials, distributing handout titled "Locations of Household Hazardous Materials." The importance of reading labels for personal safety and groundwater quality protection is emphasized. The classroom worksheet "Household Cleaners - Reading Labels" is completed and discussed.

Day 1 - home: HOUSEHOLD HAZARDOUS PRODUCTS - READING LABELS

Student carries letter to parents requesting assistance in completing home activities. Student completes home worksheet on label reading with help from a parent or adult. The handout "Locations of Household Hazardous Materials" should be taken home to provide examples of products which can be used for the label reading activity.

Teachers may wish to have several household hazardous materials on hand the following day. Students who have not completed the home worksheet may complete the exercise using the materials in the classroom.

Day 2 - classroom: MANAGEMENT OF HOUSEHOLD HAZARDOUS MATERIALS -
HOME SAFETY

Worksheets from home are reviewed and discussed. The teacher then introduces the concept of managing household hazardous waste and home safety. The handout "Cookies Aren't the Only Things Little Kids Put in Their Mouths When Grown-ups Aren't Looking" is discussed. Class prepares list of ways to use and store household hazardous materials safely.

Day 2 - home: HOUSEHOLD HAZARDOUS MATERIALS - HOME INVENTORY

Students complete home inventory of household hazardous materials using the "Cookies" handout (available from the East Michigan Environmental Action Council in brochure format).

Day 3 - classroom: KEEPING HAZARDOUS MATERIALS OUT OF THE GROUNDWATER

A master list of household hazardous materials found in the students' homes is prepared. The most common household hazardous materials are identified.

Classroom handouts are discussed to identify ways to avoid hazards to groundwater:

Handout: How a Septic System Works

Handout: Household Hazardous Materials - Routes to Groundwater

Handout: Household Materials Most Likely to Be Groundwater Hazards: Tips for Disposal

The hazardous materials on the classroom master list which are most likely to be groundwater hazards are checked off.

Day 3 - home: HOME PRACTICES TO PROTECT GROUNDWATER

The home worksheet titled "Home Practices to Protect Groundwater" is completed with help from parents or an adult. The handouts from class should be used as references for identifying safe disposal practices.

Day 4 - classroom: CONCLUSIONS

Worksheet results are discussed. The class prepares a master list of ways to reduce environmental and health hazards from household hazardous materials.

As an additional class activity, students might prepare a draft newspaper article or poster to inform and educate others about household hazardous materials.

All of the handouts and worksheets may be assembled into a "management of household hazardous materials" notebook for students to take home.

It is expected that teachers will modify the above sequence to fit individual classroom needs. The East Michigan Environmental Action Council welcomes suggestions for expanding on these materials.

Complementary classroom activities related to groundwater quality protection in the community may be found at the end of Part III of this Sourcebook.

*Activities developed by Alice Tomboulion, Paul Tomboulion, and Lillian Dean, and piloted by Ann Sibole (Walled Lake Central High School) and Barbara Velkoff (Decker Elementary School).

38

DEAR PARENTS:

As part of our study of groundwater quality, we are discussing management of household hazardous materials. Nearly everyone uses some type of hazardous material or product in the home, and it is important that students be aware of potential hazards: both to their health and the environment.

The unit on household hazardous materials has two themes:

1. The identification and recognition of household hazardous materials; and
2. Approaches for managing these products - to protect family health in the home and to protect groundwater quality.

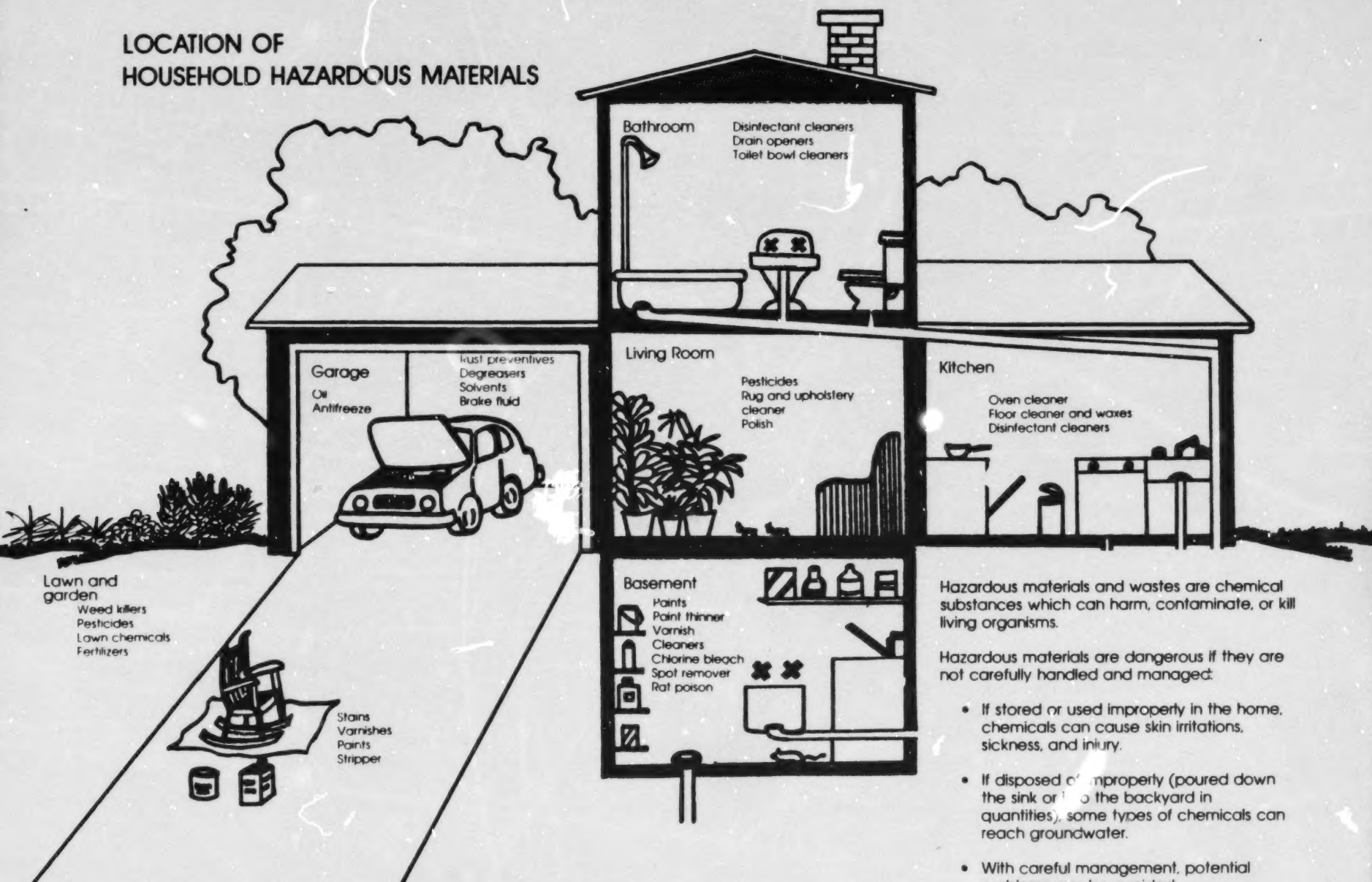
If quantities of household hazardous materials are poured down the drain or onto the backyard, the materials may reach groundwater or flow into nearby lakes and streams.

We need your help in completing several home activities. The instructions are printed on the worksheets and can be easily followed by the student. We ask your help in working with the student for safety purposes.

MAKE SURE THAT ALL CONTAINERS OF HAZARDOUS PRODUCTS ARE SECURELY CLOSED BEFORE WORKSHEETS ARE COMPLETED. WHILE WORKSHEETS ARE BEING COMPLETED, STAY WITH THE STUDENT. WHEN THE WORKSHEETS HAVE BEEN COMPLETED, PLACE THE HAZARDOUS MATERIALS IN A SAFE, CHILD-PROOF LOCATION.

Thank-you for your help and cooperation.

LOCATION OF HOUSEHOLD HAZARDOUS MATERIALS



Hazardous materials and wastes are chemical substances which can harm, contaminate, or kill living organisms.

Hazardous materials are dangerous if they are not carefully handled and managed:

- If stored or used improperly in the home, chemicals can cause skin irritations, sickness, and injury.
- If disposed of improperly (poured down the sink or into the backyard in quantities), some types of chemicals can reach groundwater.
- With careful management, potential problems can be avoided.

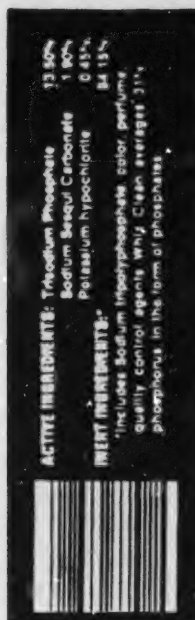
Source: Diagram from Metropolitan Seattle Sleuth report, modified by the East Michigan Environmental Action Council

BEST COPY AVAILABLE

HOUSEHOLD CLEANERS - READING LABELS

Bleaches out food stains
Cleans and Disinfects

USE WHIZ CLEAN ANYWHERE IN YOUR HOME



KITCHENS

Sinks: Whiz Clean cleans and whitens porcelain, cleans stainless steel to a sparkle.

Countertops, Plastic Surfaces: Whiz Clean bleaches through food, beverage, ink stains. Wet, sprinkle Whiz Clean, let soak for a while, then rub only as needed, rinse. Do not soak for prolonged periods.

Pots & Pans, Stoves, Ceramic Cookware: Whiz Clean cuts grease, scours off cooked-on food.

BATHROOMS

Sinks, Tubs, and Showers: Whiz Clean disinfects as it cleans.

Ceramic Tile, Fixtures: Whiz Clean cleans to a sparkle.

Toilet Bowls: Whiz Clean cleans and sanitizes. Sprinkle Whiz Clean liberally into bowl, scour and flush.

Vanity Tops, Plastic Fixtures: Special care should be taken in cleaning these surfaces. Let Whiz Clean work a minute or so with plenty of water. Rub gently if needed, and rinse.

FOR TOUGH JOBS: For easiest results, let Whiz Clean work with water a minute or so, then rub as needed and rinse.

Other Uses: Whiz Clean cleans away soil and stains on cement floors, garbage cans, auto chrome, whitewall tires, outdoor grills.

WHIZ CLEAN!

Household Cleaner

Bleaches out food stains
Cleans and Disinfects



Net Wt. 17 oz. (1 lb., 1 oz.)

- What is the brand name of this product? _____
- What is the product used for? _____
- What is the total weight of the product? _____
- List each active ingredient (chemical name and % weight) and calculate the weight for each:

Chemical Name	% Total Weight	Weight of Ingredient
_____	_____	_____
_____	_____	_____
_____	_____	_____

- How should this product be used or applied? Circle all directions listed on the label above.
- Are any of the directions warnings or precautions for protecting health and the environment?
_____ YES _____ NO
- What types of warnings or precautions might be included on the label of a household hazardous product? (List your suggestions on the back of this worksheet).

Source: Metropolitan Seattle Sleuth report

HOUSEHOLD HAZARDOUS PRODUCTS-READING LABELS

Instructions: With assistance from a parent or an adult, find a container of a household hazardous product, such as a household cleaner. Read the label carefully. Then answer the questions.

1. What is the brand name of the product (if any)? _____
2. What is the product used for? _____
3. What is the total weight or volume of the product? _____
4. List each active ingredient (chemical name and % weight or volume) and calculate the weight or volume of each ingredient:

<u>Chemical Name</u>	<u>% Weight or Volume</u>	<u>Weight or Volume of Ingredient</u>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

5. Does the label tell you how much to apply each time the product is used? _____
6. How many applications would it take to use up the entire container?
(To answer #6, ask an adult to help you make an estimate) _____
7. List instructions for using the product:

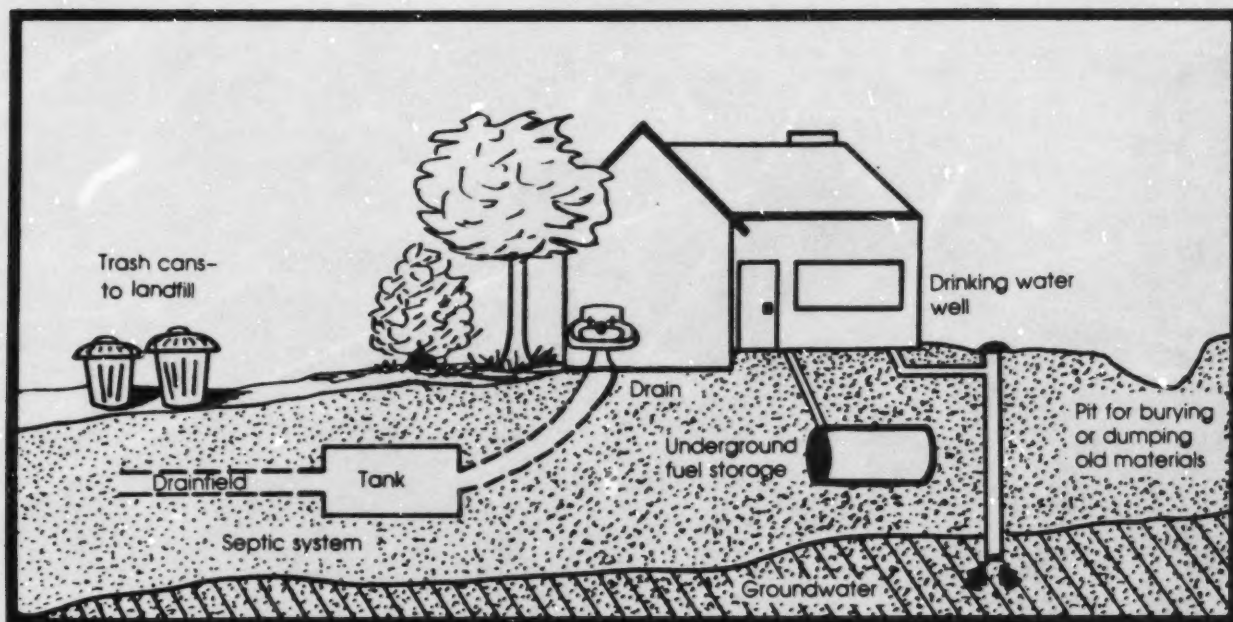
8. List instructions for storing or keeping the product (if any):

9. List instructions for disposing of the product or container (if any):

10. Circle the instructions (from #7, #8, and #9) which are warnings or precautions for protecting health and the environment.

Source: East Michigan Environmental Action Council

HOUSEHOLD HAZARDOUS MATERIALS- ROUTES TO GROUNDWATER



1. Septic system: Some hazardous materials, such as solvents, paint thinners, oil, and antifreeze (among others) are not broken down in the septic system or the surrounding soils. Groundwater hazards are increased if the septic system is overloaded with water.

(Note: Drain openers, chlorine bleach, oven cleaner, and toilet bowl cleaner may be poured down the drain or toilet with plenty of water. These materials become chemically deactivated and do not normally remain hazardous.)

2. Underground fuel storage tank: Leaking underground fuel storage tanks may contaminate groundwater. Abandoned, out-of-use tanks (with some fuel remaining in them) may also pose problems.
3. Pit for burying or dumping hazardous waste: Household hazardous materials, including paints, thinners, oil and pesticides should not be dumped or buried in the ground. Rainwater seeping through the soil may pick up and carry hazardous chemicals to groundwater.
4. Landfill: In many communities, household trash is carried to a sanitary landfill for disposal. It is legal in Michigan to dispose of household hazardous waste in licensed sanitary landfills. However, it is best to minimize the amount you discard, since landfills are not designed to handle hazardous materials.

To minimize potential problems, keep small amounts of leftover material in their original containers and wrap with newspapers or plastic bags. Additional suggestions are listed on the chart titled "Household Materials Most Likely to Be Groundwater Hazards - Tips for Disposal".

Source: East Michigan Environmental Action Council

"COOKIES AREN'T THE ONLY THINGS LITTLE KIDS PUT IN THEIR MOUTHS WHEN GROWN-UPS AREN'T LOOKING"

Poisons by the dozens are in every home. This year, over 31,000 people will be accidentally poisoned by common household items in the Detroit and Wayne County areas alone. More than 20,000 of these people will be children under ten. Many of these children will be toddlers under the age of two. Very little kids may take a gulp of floor cleaner or swallow a bottle of vitamin pills because they don't know any better. But you do.

Do you know what's poison in your home?

Medicines and Health Aids

Pills, vitamins, cough preparations, prescription drugs may be good for some people at the right time in the right amounts. But a little kid can get into big trouble by taking a pill which was meant for a grown-up — and bigger trouble by taking the whole bottle. Never tell a child that medicine is candy. Never give a child more medicine than the directions tell you to. Remember that little kids like to imitate grown-ups, including taking the pills they see grown-ups take.

Pesticides

Bug sprays, rat killers, ant poison and the like can poison people too — especially children. Keep them out of reach of children. Keep crumbs of food from meals and snacks cleaned up so animal and insect pests won't find reason to visit your home!

Hobby and Home Improvement Materials

Glues, paints, varnishes, solder and thinners are poisonous if swallowed. The vapors in paint removers are especially harmful to breathe — for children and for grown-ups. Do projects which require these products outdoors or in well-ventilated rooms — and don't eat or leave food in these areas.

Home and Laundry Products

These often contain harsh chemicals which cause immediate and severe injury if swallowed. Many are equally harmful to the skin and eyes. For your own safety as well as for the child's, handle and store with extreme caution things like: detergents, bleach, disinfectants, window cleaners, drain openers, room deodorizers, oven cleaners, furniture polish...

Beauty and Grooming Aids

These are colored and scented to look and smell good — good enough to make a child eat or drink them. Most would not normally be considered dangerous. If a child swallows a large quantity of a cosmetic, hair, skin or nail care product, these products can be dangerous too.

Dust, Dirt and Peeling Paints

Lead is still a major cause of permanent injury. Dust and scrapings from old painted surfaces may contain lead. If your home has places where paint is flaking off, keep the places swept up. Children sometimes eat paint chips instead of food. Don't let little kids chew on window sills or other painted surfaces.

Do you know where the poisons are in your home?

KITCHEN ☐ oven cleaner ☐ drain cleaner ☐ furniture polish & wax ☐ metal polish ☐ powder & liquid detergents ☐ scouring powder ☐ dishwasher detergent ☐ other cleaners ☐	BEDROOM ☐ prescription drugs ☐ other drugs ☐ cosmetics ☐
BATHROOM ☐ prescription drugs ☐ diet pills ☐ aspirin & Tylenol ☐ other pills ☐ tile cleaner ☐ drain cleaner ☐ toilet bowl cleaner ☐ disinfectants ☐ rubbing alcohol ☐ lotions & liniments ☐ hair remover ☐ nail polish & remover ☐ shampoo, wave lotion, hair spray ☐ perfume, colognes, shaving lotion ☐	LAUNDRY ☐ bleach ☐ ammonia ☐ soaps & detergents ☐ bluing, dyes ☐ spot grease removers ☐ fabric softeners ☐
CLOSETS, ATTICS STORAGE PLACES ☐ rat poison ☐ ant poison ☐ moth balls ☐ pet products ☐	GARAGE, BASEMENT, WORKSHOP ☐ gasoline ☐ kerosene ☐ lubricating oil ☐ lighter fluid ☐ antifreeze ☐ paints & stains ☐ paint stripper ☐ paint thinner ☐ varnish & shellac ☐ glues & adhesives ☐ art supplies ☐ bug killers ☐ weed killers ☐ fertilizer ☐ swimming pool chemicals ☐
	ALL ROOMS ☐ tobacco products ☐ alcoholic beverages ☐ room deodorizers ☐ houseplants ☐

You can't keep the little kids in your house from exploring but you can

be sure the treasures they find aren't POISON.

- Keep potential poisons out of sight and out of reach.
- Read labels, follow directions.
- Don't use or store pesticides or cleaning supplies near food or drink.
- Keep products in original containers. In case of poisoning you will need to know what is in the product.
- Throw away prescriptions and household products you don't use anymore.
- If you're using a hazardous product when the phone or doorbell rings, take the product with you.
- Mop or vacuum floors often. Little kids play there a lot and they often put their fingers in their mouths.



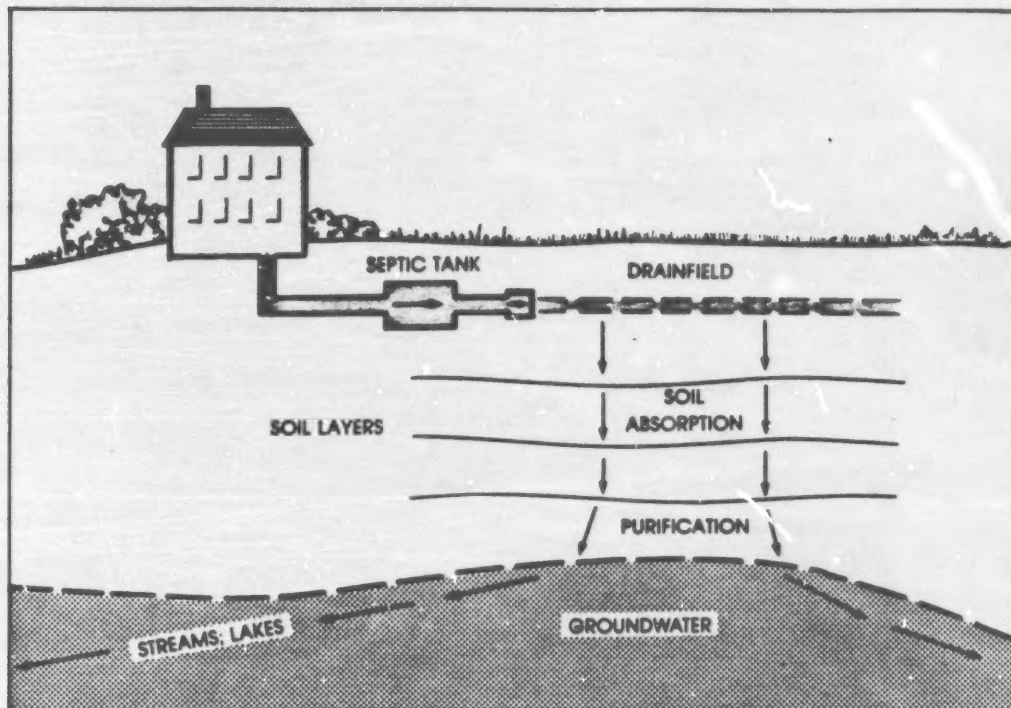
Trying on a hat from your closet can be fun for your little kid but

sampling medicine from your bathroom cabinet could be TRAGEDY.

Source: Brochure prepared by the East Michigan Environmental Action Council, One Northfield Plaza, Troy, MI, 48098. For copies of the brochure telephone (313) 879-6040.

HOW A SEPTIC SYSTEM WORKS

A septic system is composed of two units: a watertight tank through which wastewater flows and a drainfield which receives partially treated wastewater from the septic tank. In the septic tank, solid particles settle and bacterial decomposition of the settled sludge begins. When the wastewater enters the soils in and surrounding the drainfield, additional decomposition and absorption of nutrients and pollutants takes place. Both the septic tank and the drainfield must function properly to protect water quality and public health.



Source: Upper Great Lakes Regional Commission

SEPTIC SYSTEM DO's:

- .Do pump your septic tank every 1-3 years.
- .Do use water-saving fixtures.
- .Do spread clothes washing over the entire week; make full use of each load.
- .Do minimize water used for bathing and dishwashing.

SEPTIC SYSTEM DON'T's:

- .Don't allow excessive water from water softeners to enter the septic system.
- .Don't dispose of fats, oils, solvents, or thinners in the septic system.
- .Don't use a garbage grinder; it burdens the system with unnecessary waste.
- .Don't allow vehicles to drive over the drainfield.

For additional information telephone the Oakland County Health Division (313) 858-1312.

Household Materials Most Likely To Be Groundwater Hazards:

TIPS FOR DISPOSAL

Before using the disposal methods on this list, try to use up the material in the way it was intended, or give it to a friend who will use it. **Never** pour hazardous materials onto the ground, on the road, or into any water body.

Material	How to Dispose or Discard
----------	---------------------------

AUTOMOTIVE PRODUCTS AND OIL

Fuel oil	For small quantities, treat like transmission fluid (see below). For larger amounts, arrange to give to a friend with an oil furnace.
----------	---

Note: Leaks in underground oil tanks can be a serious source of pollution of the groundwater. Have tanks checked for leaks.

Used motor oil from car, tractor, snowmobile, or lawnmower	Pour into plastic jug or other container and take to used oil collection center, such as a service station.
--	---

Used radiator fluid, anti-freeze, brake fluid, or transmission fluid	Pour into plastic or metal container filled with kitty litter, dirt, or sawdust. Double wrap container in plastic bags and dispose in garbage.
--	--

PESTICIDES AND HERBICIDES

Insecticides Weed killers	Apply as directed on label to an outdoors area away from water.
------------------------------	---

If large quantities of old pesticides are found, telephone the Oakland County Health Department (313) 858-1312 or the Hazardous Waste Division, Michigan Department of Natural Resources (517) 373-2730 for advice

PAINT PRODUCTS AND SOLVENTS

Oil-based paints, Varnish, stains Thinners Wood preservatives Kerosene Gasoline	Allow to evaporate or dry out in an outdoors area away from children or pets. When mostly dry, add kitty litter, dirt, or sawdust. Then wrap with plastic bags and dispose in garbage.
--	--

Note: Paint thinner, alcohol, gasoline, and used cleaners and solvents can often be reused if the sediment is allowed to settle and the clear liquid is poured off.

Note: For disposal of household materials at a hazardous waste disposal facility call Jim Stock at Wayne Disposal Company near Ypsilanti, (313) 697-7830.

Source: East Michigan Environmental Action Council

HOME PRACTICES TO PROTECT GROUNDWATER

The list below includes household materials which are most likely to be groundwater hazards. With the help of an adult, check off the materials found in your home. Find out whether the material can be used up or whether extra material can be given away. If the material cannot be given away, identify the best method for disposal, using the classroom handout titled "Household Materials Most Likely to Be Groundwater Hazards: Tips for Disposal."

HOUSEHOLD HAZARDOUS MATERIAL	IS IT IN YOUR HOME?	CAN IT BE USED UP?	IF NOT, CAN IT BE GIVEN AWAY?	OTHERWISE, LIST THE BEST PRACTICE TO DO WITH THE EXTRA
Fuel oil				
Used motor oil				
Used anti-freeze				
Used brake fluid				
Insecticides				
Weed killers				
Paint				
Varnish, stains				
Thinners, solvents				
Wood preservatives				
Kerosene				
Gasoline				

Source: East Michigan Environmental Action Council

**THREATS TO GROUNDWATER IN
THE COMMUNITY**

Threats to Groundwater in the Community

The Challenge: Maintaining Groundwater Quality in the Community

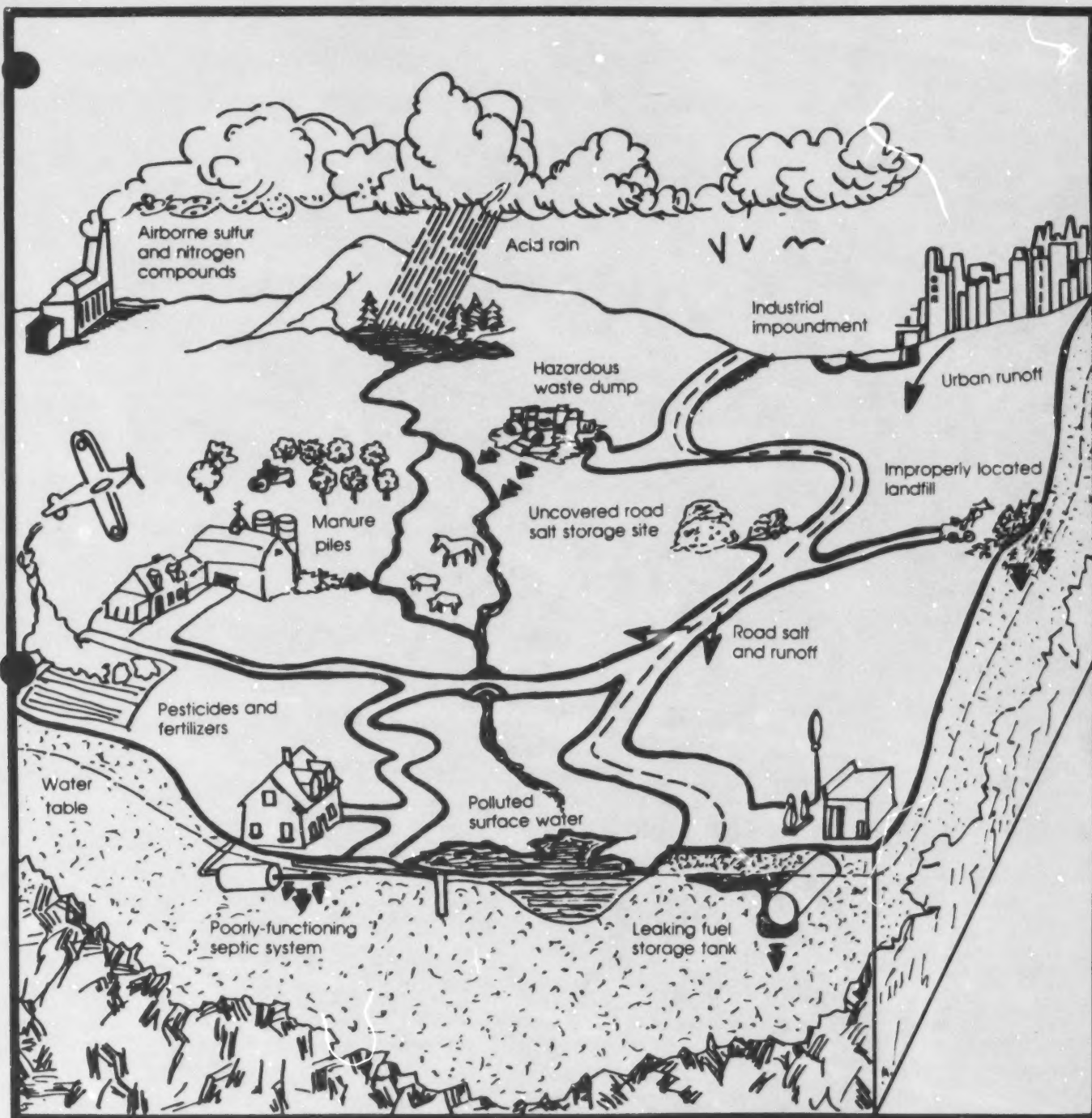
The economic and social well-being of Oakland County communities, as well as the health of residents, depends upon a continued supply of groundwater and protection of groundwater quality.

Educators and students often ask the question, "Is the groundwater in Oakland County safe to drink?" Unfortunately, a clear and accurate answer to that question does not exist.

It is difficult to make general statements about groundwater quality because many water wells have not been tested for a broad range of possible contaminants (including toxic chemicals). A variety of types of pollutants, including petroleum-related chemicals, chemicals related to solvents and degreasers, leachates from landfills, and metals have been reported in certain instances. It is hoped that the problems found in particular cases do not become widespread, and that the quality of Oakland County's groundwater can be maintained.

Throughout the nation, a category of chemicals called volatile organic compounds is a major cause for concern. Solvents, degreasers, and similar products contain volatile organic compounds. Waste motor oil also often contains traces of volatile organic compounds. Nationwide, one-third of all groundwater samples tested from contamination sites contain trichloroethylene (TCE), which is one example of a volatile organic chemical.

The challenge of protecting groundwater is made more difficult by the fact that many different types of land uses and activities may cause pollution problems. Road salt storage areas, septic systems which are functioning improperly, leaking fuel or chemical storage tanks, improperly constructed and maintained landfills, poorly constructed industrial waste lagoons, chemical waste dumps, and animal feed lots are among activities of high concern (see Figure 3-1). Volatile organic compounds found in so many contamination incidents are used in homes, manufacturing businesses, and commercial establishments. Groundwater protection must become everyone's concern--and a community-wide concern--if future problems are to be avoided.



Many Land Uses and Activities May Threaten Groundwater Quality

Figure 3-1

Source: "Contamination of Surface Water and Groundwater," Supplement to the New Hampshire Times, June 17, 1981, p. 13, Fig 10.

Sources of Groundwater Contamination in Michigan

Michigan's Act 307, passed by the Legislature in October, 1982, requires the Governor to annually identify and evaluate known sites of environmental contamination for the purpose of assigning priority for evaluation and response actions. The Michigan Department of Natural Resources completed the first year's evaluation in February, 1984. The assessment was based on available information, and resulted in a priority listing of over 850 sites, statewide.

The listing of priority environmental contamination sites indicates the sources and causes of many of the problems. Major categories of sources are listed below.

SOURCES OF ENVIRONMENTAL CONTAMINATION

State of Michigan

February, 1984

	<u>Percent of Total</u>
Landfills and illegal dumps	30%
Industry (manufacturing and bulk storage)	20%
Small business, including gasoline stations	21%
Road salt storage areas	12%
Residential wells, unknown sources	7%
Municipal wells, unknown sources	5%
Oil drilling and mining	5%
Contaminated river sediments	1%
	<u>100%</u>

Although not listed as a separate category, septic systems have been the cause of groundwater contamination in some instances.

The listing above was prepared by the East Michigan Environmental Action Council from data presented in the report "Michigan Sites of Environmental Contamination - Priority List - Act 307", February, 1984.

A significant proportion of the contamination incidents have been caused entirely or partially by gasoline, oil, and other hydrocarbon products. An estimated 36 percent of all contamination incidents at large and small business sites are related to hydrocarbons.

A significant proportion of contamination incidents can also be attributed to solvents and organic chemicals. An estimated 42 percent of large and small business site problems are related to solvents.

52

The relatively large number of contamination incidents from "unknown sources" creates problems for cleanup. If the source is unknown, it is difficult to assign legal liability and responsibility for cleanup. The difficulty in tracing sources in some cases is partly due to the way in which groundwater contamination occurs. Chemicals entering the soils may migrate some distance before they are detected. The possible sources of contamination may be numerous, creating a situation where determination of the responsible source is difficult or impossible--both from a technical and financial standpoint.

Sites of environmental contamination in Oakland County, included on the proposed priority list prepared by the Michigan Department of Natural Resources, are shown on Figure 3-2. Studies to determine the extent and complete cause of the contamination have been undertaken in only a few cases, and some sites may have been incorrectly identified by the Michigan Department of Natural Resources. Nevertheless, the listing reflects the fact that groundwater contamination is an Oakland County problem as well as a State of Michigan problem. No areas of the State are immune from potential contamination sites.

The numerous landfill, chemical dumping, and industrial problems found in Oakland County are not unexpected in view of the industrial base of Southeast Michigan. Fortunately, soil conditions in much of Oakland County are a mixture of sand and clay materials. If only sandy soils were present in Oakland County, the sites of groundwater contamination would probably be more extensive.

Although much of the groundwater in Oakland County and the State of Michigan is believed to be safe for drinking, it is suspected that many sites of environmental contamination have not been identified. Groundwater testing for hazardous chemicals in private water wells is not routinely done, due to the cost. Many toxic organic chemicals are colorless, tasteless, and odorless in the concentrations at which they occur in drinking water. In the tests which are being completed, low levels of chemical contaminants are appearing in unexpected locations. Although the levels are often very low, they are chemicals which are not naturally occurring and should not be in drinking water supplies.

Governor Blanchard has proposed expenditures of over \$20 million to pay for remedial action at groundwater contamination sites. The funding will be used to complete technical studies (often costing \$1 million or more at a single site), removal of contaminated soils and barrels of toxic materials, and provision of alternative drinking water supplies. The extent to which contaminated groundwater will actually be cleaned up at the problem sites is not known. As long as 50 to 100 years or more may be needed to address even the most severe environmental contamination sites.

Preventing groundwater contamination from occurring in the first place is a major need in the State of Michigan. The first step toward groundwater protection is the recognition of potential sources. The second step is to take specific action to reduce potential threats--both at home and at business locations.

SITES OF ENVIRONMENTAL CONTAMINATION IN OAKLAND COUNTY

Common Site Name	Nature of Incident	Nature of Pollutant
Milford Rd., Highland Area (Highland Twp.)	Groundwater contamination	Organic chemicals, etc.
Cardinal Land Corp./Veterans (Avon Twp.)	Landfill	Leachate
Lyons Twp. Dump Site (Lyon Twp.)	Barrel dump; waste pits	TCE, PCE, others
Rose Twp. Dump Site (Rose Twp.)	Chemical dump site	Industrial waste
Industrial Services of Amer. (Auburn Hills)	Landfill	Phenols, others
Sandfill Landfill (Avon Twp.)	Landfill	Solvents
Rose Twp. Cemetery Site (Rose Twp.)	Dump site	Industrial waste
National Twist Drill & Tool (Avon Twp.)	Seepage lagoon & landfill	Heavy metals
Springfield Twp. Dump Site (Springfield Twp.)	Chemical dump site	Industrial waste
Old Dump at Adams Rd. LF (Avon Twp.)	Landfill	Leachate
Christianson Dump (Avon Twp.)	Landfill	Leachate
Great Lakes Container Corp. (Pontiac)	Drum reclam. & handling	Paints, solvents, others
Sanicem Landfill/J. Fons Co. (Auburn Hills)	Landfill	Leachate
Hi-Mill Manufacturing (Highland Twp.)	Industrial operations	Heavy metals
Bald Mountain Rec. Area (Orion Twp.)	Dump, barrels, pits	-
Collier Rd. Landfill (Pontiac)	Landfill	Refuse
Industrial Services of Am. (Auburn Hills)	Landfill	Phenols, NH ₃ , etc.
Lanthier Found. & Mach. (Oxford)	Foundry	PCE, ethyl-alcohol
Village of Milford Landfill (Milford Twp.)	Landfill	Solid waste, solvents
Buckeye Pipeline (Independence Twp.)	Pipeline	Fuel oil

Common Site Name	Nature of Incident	Nature of Pollutant
Garavaglia Disposal (Orion Twp.)	Landfill	Refuse
M.A.L. Ent. #3 (Avon Twp.)	Landfill	Solid waste
Silver Bell Ski Area (Auburn Hills)	Landfill	Fill, metals
Davis Manufacturing (Clawson)	Manufacturing	TCE, oil
Fisher Cleaners & Laund. (Waterford Twp.)	Laundry & Dry cleaning	PCE
Oakland Co. Road Comm. (Pontiac)	Landfill	-
Powell (Ben) Disposal Site (Independence Twp.)	Landfill	Leachate
Residential wells (Lake Orion)	Residential wells	Chlorides
Oakland Co. Rd. Comm. (Lake Orion)	-	-
Southeast Oakland Co. Incin. Authority (Avon Twp.)	Landfill	-
Old Fons Sanitary Landfill (Troy)	Landfill	-
Anderson Municipal Landfill (Novi)	Landfill	Refuse

Michigan's Environmental Response Act (Act 307, P.A. 1982) requires an annual identification and evaluation of known sites of environmental contamination in the state. The purpose of the evaluation is to assign priorities for evaluation and response actions. The listing above reflects Oakland County sites included on the February, 1984 listing prepared by the Michigan Department of Natural Resources.

The first 14 sites are listed in order of priority, based on an assessment of risk posed to health and the environment. The remaining sites are not listed in priority, and do not appear to pose the same level of risk as the first 14 sites.

Source: Michigan Department of Natural Resources, February, 1984 Priority List, Act 307.

Waste Not . . . Want Not

Electrical Products: televisions, microwave ovens, radios, stereos, toasters, blenders.
Components: printed circuit boards, wire.
Typical Waste: cyanides, metal sludges, caustics (chromic acids), solvents, oil.

Textile-Mill Products: all clothing, leather, synthetics.
Components: dyes, materials.
Typical Waste: waste organic compounds, waste water treatment sludge, chromium shavings, solvents, metals (catalysts).

Paper and Allied Products: newspapers, magazines, books, pamphlets, brochures.
Components: paper, ink.
Typical Waste: organic by-products, solvents, waste ink, oil, waste water treatment sludges.

Lumber, Wood Products, Wood Treating: wood furniture, fencing.
Typical Waste: chromium, lead, creosote, oils, caustics, sediment sludge, pigments.

Automobiles, Trucks, Tractors:
Components: trim, bumpers, engine, body.
Typical Waste: acids, metal sludges, heat treating wastes (oils, salt solutions), paint sludges, solvents.

Public Utilities & Services: phone, electric power, gas.
Typical Waste: oil, solvents, PCB's, gas/water sludge, oil/water sludge, acid solution, metal plating (chromium, nickel, cadmium).

Universities, Colleges, Laboratories: laboratory wastes, power plant wastes.
Typical Waste: formaldehyde, alcohols, acetone, paint residues containing heavy metals, petroleum products.

Petroleum Products: gasoline, oil, diesel fuel, asphalt.
Typical Waste: waste petroleum by-products, acid sludges.

Agricultural Chemicals: pesticides, herbicides, insecticides.
Typical Waste: solvents, waste organic compounds, sludges.

Instruments, Related Products: computers, digital watches & clocks, medical diagnostic equipment.
Typical Waste: ferric chloride, acids, xylene, methylene chloride, alcohols, acetone, cadmium, nickel, zinc.

Stone, Clay, Glass Products: pottery, knick-knacks, mirrors.
Typical Waste: solvents, oil and grease.

Furniture and Fixtures: lamps, chrome furniture, brass furniture.
Typical Waste: metals, acids, solvents.

Food Industries: bottled beverages, prepared household foods, vegetable oil extraction, beet sugar extraction.
Typical Waste: lime sludge, hexane solution, used laboratory oils.

Medicines:
Typical Waste: organic solvents and residues, heavy metals (mercury, zinc, etc.)

Plastic Products:
Typical Waste: organic chlorine compounds.

Mining: utilization of heavy machinery, ore extraction process.
Typical Waste: solvents (mineral spirits), paint sludge, petroleum products, alkaline sludge, mercury.

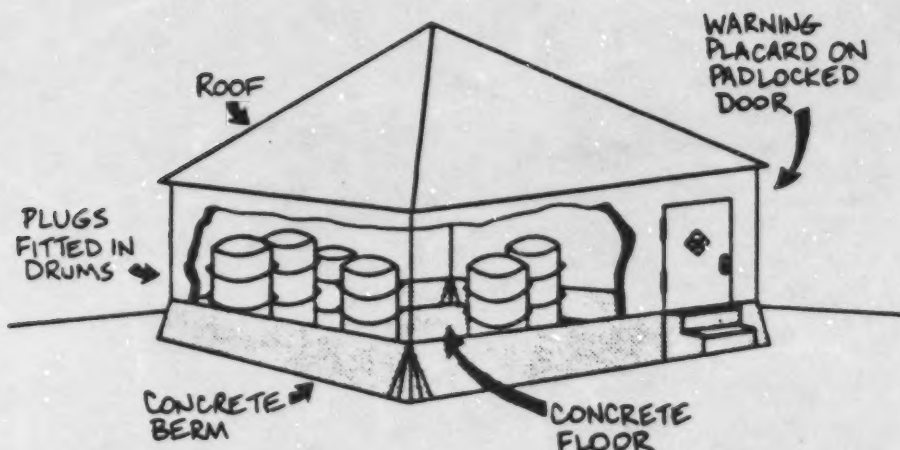
Primary Metal Industries: foundries, pipe, wire.
Typical Waste: oils, waste water treatment sludge, leach residue (chromium, lead, arsenic), coking operation sludge, solvents (alcohols, acetone, trichloroethylene), paint wastes (benzene, lead, nickel, chromium), caustics.

Source: Minnesota Waste Management Board

Storage and Handling of Materials and Waste at Business Sites

Hazardous materials and wastes are used and generated at many different types of industrial and commercial sites. Materials such as oil, ink, solvents, metals, paints and paint sludges, metal plating baths, and others are essential for industrial and commercial processes. Figure 3-3, "Waste Not....Want Not," reflects the extent to which industrial operations generate hazardous waste. The manufacture of common products such as furniture, ovens, books, and automobiles results in the generation of hazardous waste.

In addition to the manufacturing operations listed, many small businesses use and generate hazardous materials as part of their day-to-day operations. Examples of small businesses which generate hazardous waste are dry cleaners, electronic repair shops, gasoline service stations (with shops for automobile repair), automotive dealers, landscaping businesses, special trade contractors (including painting, roofing, and sheet metal contractors), printing services, research laboratories, furniture repair and refinishing services, leather tanning and finishing, instrument repair services, pest control services, cleaning services, and many others.

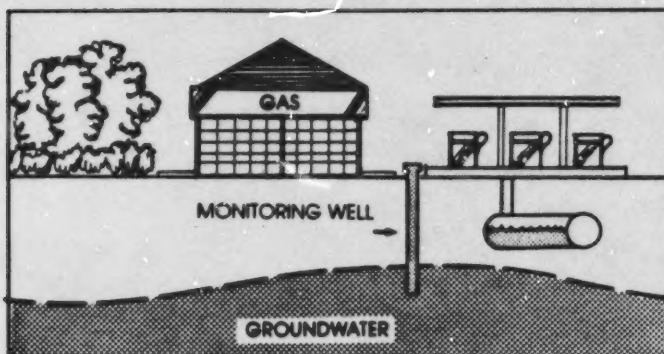


Design For Hazardous Materials Storage Shed

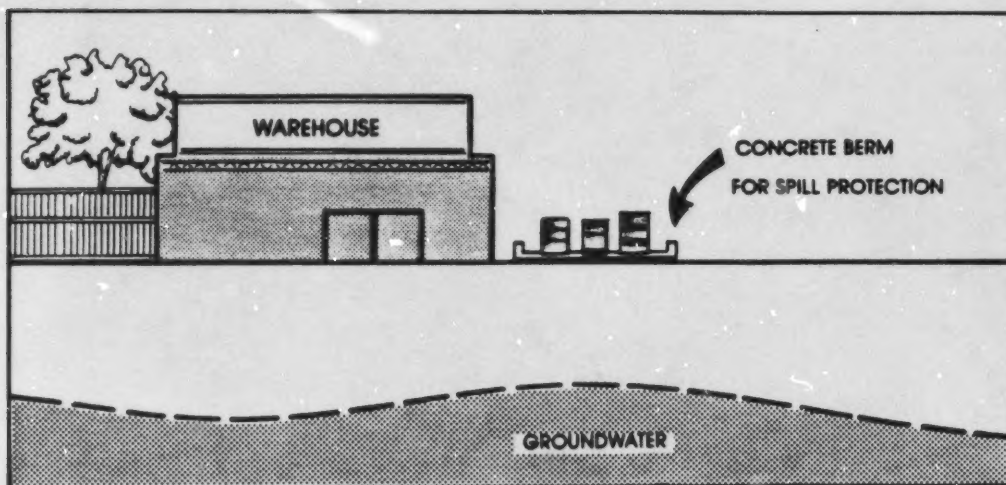
Figure 3-4

Source: Southeast Michigan Council of Governments, Genoa Township Policy Plan for Groundwater Protection, 1982, based on the "Report of the Town of Barnstable's Bylaw for the Local Control of Toxic and Hazardous Materials," p. 12.

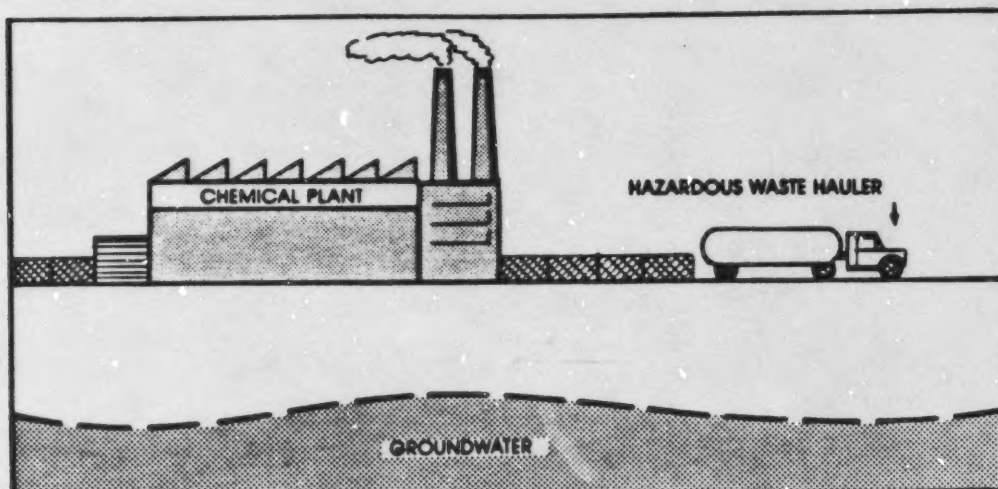
Figure 3-5
Business Owners Can Help Protect Groundwater



Careful Installation and Monitoring of Underground Fuel Tanks



Safe Storage of Hazardous Materials

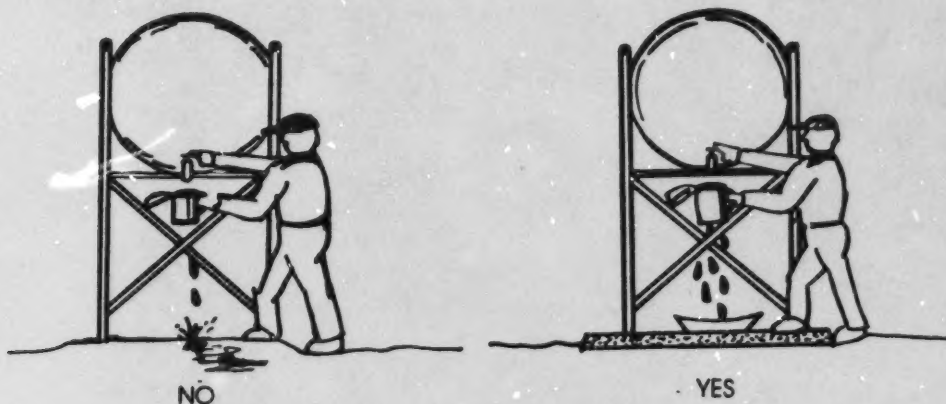


Transport of Hazardous Materials to a Licensed Hazardous Waste Facility

Hazardous materials and hazardous waste should be stored and used with care and caution to avoid both health and groundwater contamination problems. Spills and accidents near outdoor loading and storage areas, for example, may cause problems. Whenever possible, hazardous materials should be stored in buildings or covered sheds (see Figure 3-4).

With an understanding of potential problems, businesses can develop approaches for safeguarding groundwater quality in a way appropriate to the individual business. In some cases, berms around outdoor storage areas will serve to catch spilled materials before liquids runoff of the site. Monitoring wells for underground fuel storage tanks are good "insurance" against underground leaks (see Figure 3-5).

Simple steps and precautions like the use of drip pans under oil tanks can reduce spillage and environmental problems (see Figure 3-6). The awareness of employees when using and handling hazardous materials is a key. Because hazardous materials are common in the workplace, both health and environmental dangers may not seem "real" to employees or business owners.



Use Of Drip Pan To Catch Oil Spills

Figure 3-6

Source: Draft "Critical Materials Handbook,"
Spokane County, Washington, 1983.

Government oversight and regulation of the use and handling of hazardous materials at business sites is not extensive. Michigan businesses which use "critical materials"--or salt (as defined by Michigan's "Critical Materials List"), as well as storage facilities with 40,000 gallons or more of oil must submit a Pollution Incident Prevention Plan (PIPP Plan) to the Michigan Department of Natural Resources. The PIPP Plan must set forth the following:

- .procedures for preventing pollution;
- .emergency cleanup procedures;
- .the type of surveillance used to detect possible pollution; and
- .methods for keeping inventories.

Although an estimated 15,000-20,000 or more businesses in Michigan are subject to these requirements, only a relatively small number are aware of the requirements.

The most extensive regulation of underground fuel storage is through Michigan's "Rules for Storage of Flammable and Combustible Liquids." These rules, administered through the Department of State Police, Fire Marshal Division, are designed to reduce fire hazards. As a result of 1983 amendments to the rules, several of the provisions also help prevent leaks in underground fuel storage tanks.

Provisions of the "Flammable Liquids" rules which are particularly important for groundwater protection include the following:

- .Procedures for abandoning "out-of-use" tanks (removal from the ground is usually required);
- .Testing requirements for new tanks, or tanks which are suspected of leaking; and
- .Requirements for protecting the area around the fill pipe to prevent spillage.

The rules have been incorporated in the Michigan Building Code which, in turn, has been adopted by many local governments in Michigan. The actual enforcement (including inspections of sites with underground fuel storage tanks) for all but large-scale fuel storage facilities is left to local fire marshals and other local officials. In some rural communities with volunteer fire marshals, the rules may not be systematically enforced.

Management of Hazardous Waste from Business Sites

Proper management of hazardous waste at large and small business sites is a particular area of concern for groundwater quality protection. In the past, some businesses paid for waste disposal without consideration or knowledge of the final destination of the hazardous waste material. Unauthorized hazardous waste dumps which threaten groundwater quality have resulted from mistakes of the past.

A number of different technologies are available for disposing of hazardous waste. Options include chemical treatment (including chemical fixation), physical treatment (such as filtration, separation, or solidification), incineration, and land disposal. Hazardous waste landfills in Michigan must be designed to meet standards which are more stringent than sanitary landfills which receive normal trash.

Major Hazardous Waste Options in Michigan

Methods	Description of Methods	Suitable Types of Wastes	Disadvantages and Limitations	Advantages and Benefits
Waste Reduction	• Use smaller quantities • Substitute other processes and materials • Segregate non-hazardous from hazardous wastes	• All types	• Changes in processes or production might be required • May increase short term costs	• Reduces waste • Conserves resources • Saves money in long term
Recycling and Recovery	• Wastes are sold to reprocessing facility or through waste exchange network	• Many solvents • Some petroleum products • Some metals and metal sludges	• Requires segregation and collection • Needs quality controls • Needs information exchange	• Saves money • Conserves resources • Reduces waste
Chemical, Biological and Physical Treatments	• Chemical or biological methods render wastes less hazardous • Filtration, separation, adsorption of liquids • Solidification and encapsulation of solids	• Mainly specialized liquid wastes: metal and plating wastes, cyanides, acid and alkaline wastes • Some dilute organic and petrochemical wastes	• Limited applicability • Separate method needed for each waste • May produce other wastes • May produce bulky but inert wastes	• Low cost method • Effective • Simple technologies • Usually permanent • Low energy requirement • May reduce volume
Incineration	• Controlled combustion at very high temperature	• Almost all liquid, semi-solid, and solid combustible wastes	• Complex special technology • Relatively expensive • High energy requirement • Produces ash • Potential air pollution	• Reduces volume • Most effective destruction method • Permanent
Land Disposal	• Burying in secured vault	• Solids and semi-solids not otherwise managed or treated • Best for high volume or bulky wastes	• Demanding site criteria • Complex construction • May contaminate surface— and groundwater • Long-term surveillance • Not permanent solution	• Low to medium costs (may be increasing) • Handles larger quantities more readily

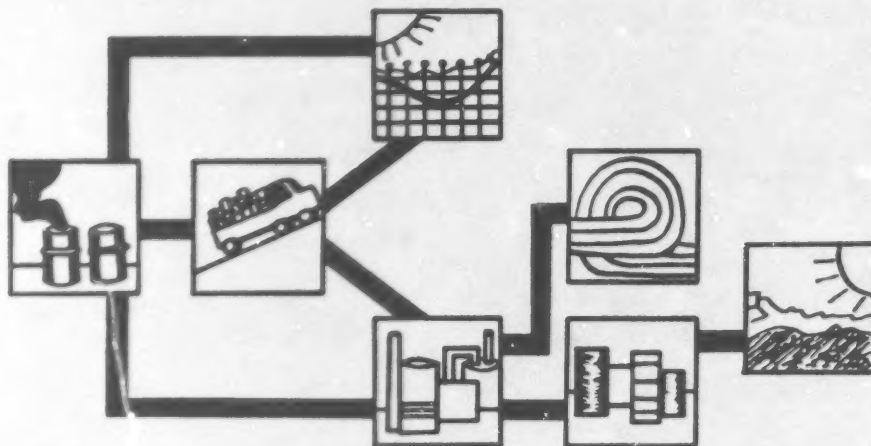
Figure 3-7

Some businesses manage and dispose of their hazardous waste at their own business sites. Others are finding economical ways to recycle and reuse hazardous wastes. Through "waste exchange" services, the "waste" of one business may find a productive use in another business. The range of hazardous waste management options and technologies for Michigan businesses is shown on Figure 3-7.

Many of the hazardous chemicals which have polluted groundwater in Michigan have their origin in industrial processes. Recognizing the dangers which hazardous waste poses to human health and the environment, the Michigan Legislature passed the Hazardous Waste Management Act (Act 64, P.A. of 1979).

The Hazardous Waste Management Act regulates the storage, transport, and disposal of hazardous waste within the State of Michigan. The law parallels and in some provisions extends beyond the federal Resource Conservation and Recovery Act (RCRA).

Michigan's Act 64 and RCRA require businesses which generate hazardous waste to track the material "from cradle to grave" regardless of the treatment method or technology used (see Figure 3-8). "Manifest" forms are prepared which describe the hazardous waste material. The manifest form stays with the waste until it reaches its final disposal location. In accordance with the requirements of Act 64, copies of manifests are transmitted to the Michigan Department of Natural Resources.



**Hazardous Waste Should Be Tracked
From "Cradle-to-Grave"**

Figure 3-8

Source: U.S. Environmental Protection Agency.
"Everybody's Problem: Hazardous
Waste", 1980, p. 9.

Businesses which generate "large quantities" of hazardous waste, that is, 1,000 kg/month or more, are required by both state and federal law to manifest their waste and use licensed hazardous waste disposal facilities. The quantity of 1,000 kg is nearly equivalent to 2,000 pounds or a ton. The generation of 4 or 5 drums of hazardous waste each month is usually 1,000 kg or more.

"Small quantity" generators producing between 100 kg and 1,000 kg/month of hazardous waste are not subject to the overall requirements of the federal Resource Conservation and Recovery Act. Small quantity generators are, however, required by Michigan's Act 64 to use licensed hazardous waste disposal facilities. Many of the incidents of groundwater contamination from industrial waste have been from small quantities, so it is important for health and environmental protection that such waste be properly managed.

It is more costly to dispose of hazardous waste at licensed hazardous waste disposal facilities than it is to use sanitary landfills (or dump the materials down the sink or drain). However, the costs to a business can be even greater if environmental problems arise. Businesses are liable for health and environmental damages resulting from pollution from their hazardous waste, even if the business itself is not directly responsible for the pollution problem.

Water Well Testing Options

Sometimes it is easy to identify contaminated groundwater from the smell or taste of the water. In most cases, the pollution is invisible. The only way to identify possible pollutants is to have a sample of the water tested in a laboratory.

Two types of testing options are available to Oakland County residents:

1. Standard drinking water test: The Oakland County Health Department offers a free water test for: bacteria, iron, nitrate, sodium, hardness, chloride, and fluoride. Toxic chemicals are not typically included in the water test.

Health officials recommend routine water tests every two to three years to insure that problems are not developing. Bottles can be picked up at county health offices for the sampling, and the results are returned to the resident by mail. Be sure to ask for both a bacteriological test and a partial chemical test.

For further information contact:

Oakland County Environmental Health
1200 N. Telegraph Road, Pontiac 48053
(313)858-1312

2. Private testing laboratories: Tests for toxic chemicals can be obtained through private laboratories. Many of the types of chemicals which are causing groundwater contamination throughout Michigan (such as hydrocarbons, solvents, and cleaners) are toxic, and would not normally be identified through the standard drinking water test performed by health agencies.

Private laboratory tests, however, involve expenses for the homeowner. Costs vary, depending on the type of test. Tests for one or two suspected toxic chemicals or a scan of a group of similar chemicals can often be completed for \$100 or less. Testing for a number of toxic chemicals, however, can cost \$600 or more.

Drinking water supplies that are believed to be unsafe should be reported to the Oakland County Health Department, (313)858-1312.

Alternatives to drinking groundwater include using bottled water or hooking onto municipal water supplies. Drilling a new, deeper well may, under some circumstances, provide a safer source of drinking water.

Laboratory tests provide information about the chemical composition of the water. In some cases, health officials "advise" homeowners not to drink the water due to chemicals and possible health dangers. For many toxic chemicals, however, national and state standards for "safe drinking water" from private wells do not exist. The decision about drinking the water, in the end, rests with the individual.

Who Is Responsible for Groundwater Quality Protection?

An array of federal, state and county agency programs affect groundwater quality in some way. However, when all of the laws and regulations are assembled and arrayed, significant gaps can be spotted. Even more significant are financial and staffing limitations for state and county agencies responsible for inspections and enforcement.

Several local governments in Southeast Michigan have taken steps to help prevent groundwater contamination in their own communities. The role of local governments, however, is often directed toward the review and approval of new development proposals. Although this is an important activity, it is not sufficient to address groundwater quality threats from existing land uses and activities in the community.

Citizen and business awareness and responsibility for groundwater quality protection is essential for the future. Because groundwater is not visible, it is often forgotten until problems arise. Many government agencies have some responsibility for groundwater protection, but the job is not being done. In the end, every citizen and business owner has the responsibility for protecting his or her own groundwater quality. Transport of hazardous materials to licensed hazardous waste disposal facilities and the provision of safe storage areas are two actions which may be carried out. (See classroom handout, "Business Owners Can Help Protect Groundwater.")

It pays to be alert for groundwater threats and hazards in the community. A problem spotted before leaks occur can save significant cleanup costs and damage to the environment. In any emergency situation, call:

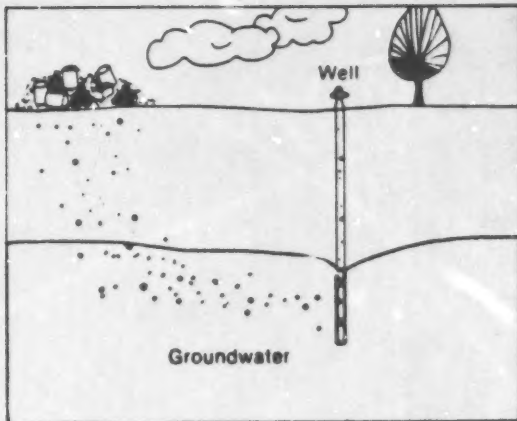
.PEAS (Pollution Emergency Alert System)--
24-hour toll-free number, operated by the
Michigan Department of Natural Resources:--
1-800-292-4706; and the

Oakland County Environmental Health Division:
(313)858-1312

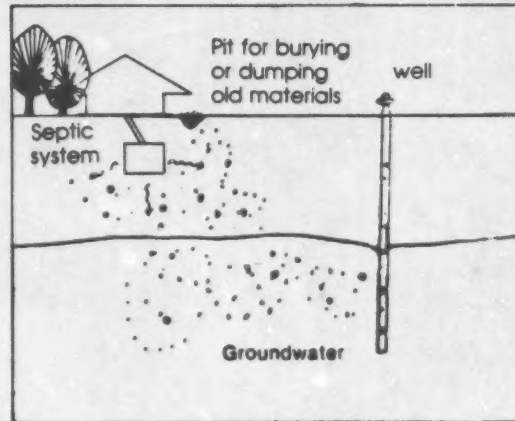
Many groundwater threats, however, are not visible spills, accidents, and emergencies. Groundwater problems are often the result of careless and thoughtless action, often repeated time and time again.

Awareness of groundwater and the potential for contamination is key. The high cost and difficulty of groundwater cleanup, together with the legal liabilities for improper hazardous waste management are important financial incentives for reducing threats to groundwater.

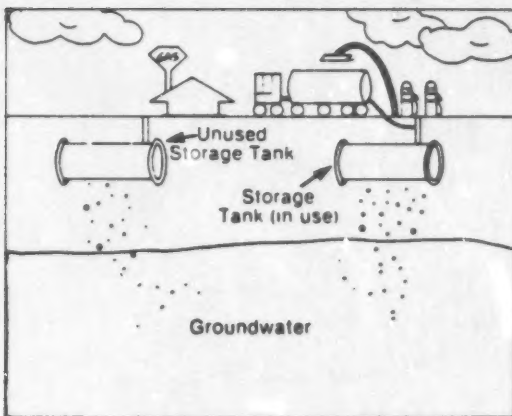
SOURCES OF GROUNDWATER CONTAMINATION IN THE COMMUNITY



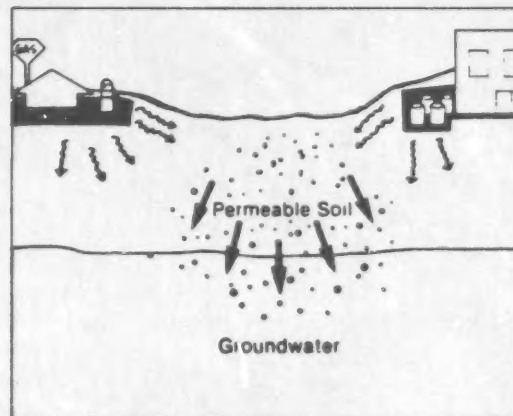
Waste Dumping



Solvents and Oils Poured
Into Home Septic Systems and
Backyards



Underground Gasoline
Storage Tanks



Runoff from Business and
Industry Sites

Source: Illustrations based on diagrams from
the Southeast Michigan Council of
Governments.

Threats To Groundwater In The Community

Classroom Activities

Classroom projects on groundwater quality protection in the community can be designed to focus on a single groundwater contamination threat or many aspects of community activities. Suggestions for guest speakers are included on the list below.

1. Community inventory of groundwater threats: Make a list in the classroom of activities in the community which are most likely to be threats to groundwater. Each student could select an activity or land use for special study, and report to the group on ways to reduce potential groundwater problems.

2. Water well testing: Using bottles provided by the Oakland County Health Department, take a sample of water (perhaps from the school) and request a free county test for bacteria and partial chemicals.

When the results of the tests have been obtained, telephone the Oakland County Environmental Health Division and invite a sanitarian to speak to the class about the results. (Telephone: 858-1312). Health Division staff could also discuss septic system functioning and maintenance with interested classrooms.

3. Hazardous waste management at business sites: Michigan's Hazardous Waste Management Act, (Act 64, P.A. of 1979) requires many businesses to dispose of hazardous waste at a licensed hazardous waste disposal facility. Students may write to their state senator or representative to obtain a copy of the law.

In communities where a central wastewater treatment system provides services to businesses, the treatment plant operator could be invited to the classroom to discuss hazardous waste management. Representatives from businesses in the community may also be able to discuss environmental protection and the activities at their business.

4. Cleanup of groundwater pollution sites: Groundwater contamination has been found at sites throughout Oakland County and the State of Michigan. As a classroom activity, a newspaper file documenting cleanup activities at a particular site could be organized. Representatives from the local government or county health department could be invited to speak. Active citizen organizations in the area are often willing to meet with interested students as well.
5. Hazardous waste management in classroom laboratories: School science laboratories have hazardous chemicals which require careful handling and disposal. As a class project, complete an inventory of hazardous materials in the laboratory, and prepare a list of handling and storage instructions. Through the Michigan Department of Education, plans are being made to encourage disposal of hazardous laboratory wastes at licensed hazardous waste disposal facilities. For further information contact Dr. Don Maxwell, Oakland Schools, 858-2005.

Aquifer: Any subsurface material that holds a relatively large quantity of groundwater and is able to transmit that water readily.

Contaminant: All materials which enter the hydrologic environment as a result of man's activities, regardless of whether or not the concentrations reach levels that cause significant degradation of water quality.

Evaporation: The process of converting a liquid material to a vapor.

Evapotranspiration: The loss of water from the soil through evaporation and transpiration.

Glacial drift: A general term applied to sediments such as sands, gravels, and clays that are deposited by glaciers. Glacial drift sediments can range in size from tiny clay particles to large boulders.

Groundwater: Underground water in a zone of saturation.

Hazardous waste: Wastes which can harm, contaminate, or kill living organisms. Hazardous waste may be toxic, corrosive, reactive, and/or ignitable.

Hydrologic cycle (also called the water cycle): The circular flow or cycling of water from the atmosphere to the earth by precipitation and back to the atmosphere by evaporation and transpiration. While on the earth's surface, water is involved in many processes such as runoff, infiltration into the soil, storage in depressions, lakes and streams, and storage as groundwater.

Infiltration: The process by which water seeps into the ground through the surface.

Interflow: Infiltration water that moves laterally in the soil and seeps into stream channels.

Overland flow: Runoff from surfaces on which the intensity of precipitation or snowmelt exceeds the infiltration capacity.

Pollution: Situations where contaminant concentrations attain levels that are considered objectionable.

Precipitation: All moisture - solid and liquid - that falls from the atmosphere.

Recharge: The replenishment of groundwater with water from the surface.

Runoff: Surface discharge of water in the form of overland flow and channel flow.

Septic system: An on-site (small-scale) sewage disposal system that depends on the soil to dispose of wastewater.

Toxic: Acting or likely to act as a poison.

Transpiration: The flow of water through the tissue of a plant and into the atmosphere via openings (stomata) in the foliage.

Water table: The upper boundary of the zone of groundwater. In fine-textured materials, the water table is usually a transition zone rather than a boundary line. The configuration of the water table often approximates that of the overlying terrain.

Watershed: The land areas which drain into a particular river, stream, or lake.

Center for Science in the Public Interest, The Household Pollutants Guide, Anchor Books, Garden City, New York, 1978, 309 pp. (paperback).

.Compilation of information on household hazardous materials, including chemical characteristics of common products, health hazards, and tips for reducing hazards in the home. Check your library for availability--this useful guide is now out of print.

Dunne, Thomas, and Luna B. Leopold, Water in Environmental Planning, W.H. Freeman & Company, San Francisco, 1978, 817 pp.

.Technical reference on principles of the hydrologic cycle, erosion and runoff processes, water use by vegetation, groundwater and river water quality, among others.

East Michigan Environmental Action Council, 1984 West Oakland/East Livingston Groundwater Protection Calendar. (Single copies available free while the supply lasts; write or telephone EMEAC, One Northfield Plaza, Troy, MI 48098; (313)879-6040.)

.Practical illustrated booklet for citizens about groundwater protection needs and steps which individuals can take to protect groundwater. Covers septic system maintenance, pesticide/fertilizer use, household hazardous waste, roles of businesses and local governments in groundwater protection, and other topics.

East Michigan Environmental Action Council, "Cookies Aren't the Only Things Little Kids Put in Their Mouths When Grown-ups Aren't Looking," 1983 brochure, 4 pp. (Copies available for classroom use. Contact EMEAC, One Northfield Plaza, Troy, MI 48098; (313) 879-6040.)

Freeze, R. Allan and John A. Cherry, Groundwater, Prentice Hall, Englewood Cliffs, N.J., 1978, 604 pp.

.A technical reference on groundwater, including groundwater contamination, geology, and chemistry. This book is widely recognized and used as a basic college text on groundwater.

Marsh, William M. and Jeff Dozier, Landscape: Introduction to Physical Geography, Addison-Wesley Publishing Company, Inc., Reading, Mass., 1981, 637 pp.

.College textbook with excellent illustrations and examples of physical aspects and processes at work in the environment. Includes the hydrologic cycle, runoff and streamflow, groundwater, infiltration and soil moisture, glacial processes, and many others.

Michigan Department of Natural Resources, Assessment of Groundwater Contamination: Inventory of Sites, 1982, 242 pp. (paperback).

.DNR's initial listing of known and suspected sites of groundwater contamination, together with one-page fact sheets about land use activities which are presenting groundwater contamination threats in Michigan. Maps of the state illustrate the geographic distribution of land uses potentially creating groundwater contamination problems.

Michigan Department of Natural Resources, Michigan Sites of Environmental Contamination--Proposed Priority List, Act 307, February, 1984.

.Priority groundwater contamination sites resulting from an assessment of health and environmental threats. Background information on Act 307 and the scoring process included.

Michigan Department of Natural Resources, Filmstrip and Instructor's Manual, Understanding Groundwater. (Available for purchase from Woolly Bear Productions, a Division of Michigan Natural Resources Magazine, Box 30034, Lansing, MI 48909; (517)373-9267. Also available on loan through the Media Center, Oakland Schools.)

.Seven-minute filmstrip with tape cassette providing an overview of groundwater and threats to groundwater in Michigan. Excellent illustrations and text provide an introduction to the subject of groundwater quality protection.

Michigan State University, Cooperative Extension Service, Water, Basic Environment Series, 4-H Youth Program, 16 pp. (Available through the Oakland County Cooperative Extension Service Office, 1200 N. Telegraph, Pontiac, MI 48053; (313)858-0880; small charge.)

.Student materials and leader/teacher guide on basics of water, including the water cycle and water pollution. Illustrations and easy-to-do projects included. Particularly useful as an introduction to water resources at the elementary school level.

National Wildlife Federation, The Class Project, Washington, D.C., 1982, 134 pp. (Available through Oakland Schools Workshop, scheduled for Fall, 1984. For further information contact Donald Maxwell, Oakland Schools, 858-2005; or the Michigan United Conservation Clubs, 2101 Wood St., P.O. Box 30235, Lansing, MI 48909.)

.Loose-leaf notebook with background information and project ideas. Posters on energy use, environmental issues, forest/watershed management, hazardous substances, wetlands, and wildlife habitat management are included. The Class Project is designed to help teachers make environmental education part of the junior high or middle school curriculum. The program encourages classes to initiate environmental projects in their localities and be recognized as part of a nationwide network of Conservation Classrooms.